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OPERATIONS ON THE EAR

OPERATIONS ON THE EAR

THE OPERATIONS FOR SUPPURATIVE
OTITIS MEDIA AND ITS INTRACRANIAL
COMPLICATIONS

BY
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TRANSLATED AND EDITED FROM THE SECOND GERMAN EDITION

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TRANSLATOR'S PREFACE

IN preparing the English version of Professor Heine's admirable book, 'Operationen am Ohr,' I have kept in the main as closely as possible to the original text. Besides the changes demanded by the difference of idiom, however, a few other alterations seemed expedient. I have rearranged the division of the book into chapters in a way more suitable, as I think, for English readers, and I have been able, without sacrifice of clearness, to omit a few sentences here and there and some long notes in which questions of terminology are discussed.

My best thanks are due, in the first place, to Professor Heine for allowing me to translate his book, and also to Herr Karger of Berlin, the publisher of the German edition, for facilitating in every way the production of an English version. Further, I am indebted to Messrs. Baillière, Tindall and Cox for the manner in which they have carried out the work of publication.

W. LOMBARD MURPHY.

33, UPPER MERRION STREET,
DUBLIN,
October, 1908.

AUTHOR'S PREFACE TO THE SECOND GERMAN EDITION

THE first edition of this work has been received in a most encouraging way both by specialists and by general surgeons ; there evidently existed, as I believed, a demand for a text-book describing the various operations on the ear. Moreover, judging by the published criticisms, it seems that I was right in following the plan of basing the subject-matter of the book on our experience in Lucae's clinic, where I worked as assistant until April, 1906. I have therefore in this edition kept to the same general scheme.

Several of the sections have been considerably expanded, and the chapters on labyrinth suppuration and meningitis have been entirely rewritten, on account of the recent advances in our knowledge of these diseases. I have added a full account of the treatment of mastoiditis by passive congestion, although most aurists have now abandoned this method. I think the congestion treatment should be further tested ; it may be found useful in certain types of cases still to be defined.

B. HEINE.

KÖNIGSBERG, PRUSSIA.

EXTRACT FROM THE AUTHOR'S PREFACE TO THE FIRST GERMAN EDITION

. . . THE figures of instruments are taken from the catalogue of Messrs. Windler, who kindly placed the blocks at my disposal. The drawings of the tympanic membrane are from life ; the remaining illustrations, with the exception of those representing the Passow and Mosetig-Moorhof plastic operations, are from my own anatomical and pathological specimens. The drawings were made with remarkable skill by Fräulein Lisbeth Krause. My heartiest thanks are due to my honoured chief, Professor Lucae, for allowing me to make use of the material in his clinic.

B. HEINE.

BERLIN, 1903.

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PART I

OPERATIONS FOR SUPPURATIVE OTITIS MEDIA

CHAPTER I

OPERATIONS ON THE
TYMPANIC MEMBRANE AND IN THE
TYMPANIC CAVITY.

1. PARACENTESIS: Indications—The operation—After-treatment and value of the operation. 2. THE REMOVAL OF GRANULATIONS AND POLYPI. 3. EXTRACTION OF THE OSSICLES: Indications—The operation—After-treatment and value of the operation.

1. PARACENTESIS.

PARACENTESIS for the relief of deafness is said to have been performed for the first time in the second half of the eighteenth century by a quack doctor named Eli in Paris. Himly and Cooper, in the beginning of the nineteenth century, were the first who obtained general recognition for the operation among aurists. They recommended it for deafness caused by closure of the Eustachian tube. Others, again, made an incision in the membrane when it was found to be thickened, but the ill-success of the operation in these cases gradually became apparent. In a few cases the results were good, probably accidentally, and these were always followed by failures, so that the operation fell more and more into discredit, and was finally abandoned altogether.

Between 1860 and 1870 Schwartze reintroduced the operation into aural surgery, and obtained for it a recognized place by working out the indications on scientific lines. He abandoned the old idea that the operation could be of use to relieve or cure deafness in general, and pointed out that paracentesis is primarily suitable for the removal of fluid from the tympanic cavity.

Indications.

The following are the indications for the operation, according to Schwartz:

1. In severe acute and in chronic catarrh, when the amount of exudate in the tympanic cavity is so large that the drum appears bulged outwards or flattened, or when, on catheterization, no sound can be heard through the otoscope. When there is less exudate, the operation is not indicated unless palliative treatment, especially catheterization, fails to cause lasting improvement.

2. In acute purulent middle-ear disease, if spontaneous perforation of the drum is delayed.

3. When signs of retention of pus appear in chronic suppurative middle-ear disease associated with a small or high perforation of the drum.

4. In acute myringitis, with much swelling of the drum and severe pain. Further, incision of the drum may be employed for diagnostic purposes—for instance, in order to ascertain if there is any fluid present in the tympanic cavity; and, finally, it is useful for improving the hearing in cases of abnormal tension of the drum.

With regard to the last indication, Schwartz himself says that the results are uncertain, and that we must hope in the future to be able to select by improved diagnostic methods the cases suited for the operation.

Incision of the drum for the relief of deafness—*e.g.*, cutting through the posterior fold—has been gradually abandoned since aurists have realized that the membrane plays a much less important part in hearing than was formerly supposed.

The main question here is: When is paracentesis indicated in middle-ear inflammation? In answering this question, I hold in principle to Schwartz's views; but before discussing the indications in detail, it is necessary to say a few words on the subject of the classification of otitis media.

Clinically, a sharp distinction must be made between **catarrh** and **inflammation** of the middle ear (this has also been pointed out by Politzer, Walb, Jacobson, and others). By **acute catarrh of the middle ear** we understand a pathological condition of the tympanic cavity brought about by mechanical causes—that is, by permanent closure of the Eustachian tube, or its temporary stoppage from catarrh. The drum is indrawn, showing clearly that the air in the tympanic

cavity is rarefied, as a consequence of being shut off from communication with the atmosphere. A fold is seen running downwards and backwards from the short process of the malleus ; this is known as the posterior fold of the drum, and is not visible under normal conditions. The handle of the malleus appears foreshortened. Shrapnell's membrane is often indrawn and shows a small light reflex. When the drum is much indrawn, the short process of the malleus projects like a beak, and from it a small fold may sometimes be seen running upwards and forwards. The membrane is somewhat reddish in colour, instead of the normal pearly grey. The vessels of the handle of the malleus may be injected, but this sign is not constant. The short process itself is unaltered in appearance ; there is no swelling around it. The reddish colour of the drum is due to hyperæmia of the mucous membrane, and this in its turn is caused by the rarefaction of the air. It is important to remember that the mucous layer only is hyperæmic, and the drum therefore does not lose its gloss. As a final result of the negative pressure in the tympanic cavity, a serous or muco-serous fluid may be secreted. This fluid is commonly but incorrectly spoken of as an exudate ; it is, strictly speaking, a transudate. If the amount of fluid in the cavity is small, a line will be seen on the drum corresponding to the surface of the fluid within ; whereas, if the tympanic space is completely filled up, the membrane takes on a yellowish-brown colour, and presents a characteristic transparent appearance. The picture is particularly striking if we compare the drum with that of the opposite side, supposing, of course, that the latter is healthy. If there is still doubt as to the presence of fluid, a definite diagnosis can usually be made by catheterization of the Eustachian tube. When air is blown in through the catheter a characteristic crackling sound is heard if fluid is present ; only when the secretion is very viscous is the sign absent.

Acute inflammation of the middle ear is generally due to an extension of inflammation from the mucous membrane of the pharynx or Eustachian tube. It presents, even in the early stages, a picture altogether different from that of catarrh : the vessels of the handle of the malleus are more injected ; the region of the short process is more or less swollen, and the process itself becomes ill-defined and hazy ; the whole drum is duller and less glossy than usual. Yet it is not always possible to say on the first examination whether we have to deal with an acute catarrh or an acute inflam-

mation. Transition forms occur, and inflammation may develop from an acute catarrh. On one day we may see a well-marked line, corresponding to the upper surface of the fluid, shining through the tympanic membrane, and on the next the whole drum is diffusely inflamed and quite opaque. Conversely, an attack of inflammation may subside with disappearance of the swelling of the drum, while the exudation, easily recognizable by the characteristic surface line, remains for some time in the tympanic cavity.

It is outside the scope of this book to discuss here the pathological, anatomical and bacteriological points for and against this distinction between catarrh and inflammation of the middle ear. I admit that there is some evidence against making the division, but I consider it desirable for clinical and practical reasons.

In acute otitis media paracentesis is indicated, as Schwartz pointed out, when fluid has collected in the cavity, and there is no sign of spontaneous perforation taking place.

Some doubts have been expressed recently as to the necessity of emptying the tympanic cavity of its pathological contents. Zaufal and his pupil Piffl,* after long experience and observation, are in favour of limiting this indication for paracentesis. In their opinion, genuine middle-ear inflammation, especially in children, runs a definite cyclic course, somewhat similar to that of pneumonia. It begins, they say, with a rigor, followed by high fever and severe pain, the inflammatory appearances on the drum being strongly marked; on the seventh or eighth day a sudden change takes place, and recovery follows without spontaneous escape of the secretion. Zaufal no longer performs paracentesis in the early stages in these cases, but waits till the seventh or eighth day. He recommends hot compresses of aluminium acetate solution locally and sodium salicylate internally.

With all respect for the great authority of Zaufal, I cannot adopt his view, as I have not observed that cases of middle-ear inflammation run the cyclic course described by him. I hold, therefore, firmly to the old surgical maxim: "Ubi pus, ibi evacua."

To resume: If the drum is locally or generally bulged outwards, and a slight yellowish discoloration points to the presence of secretion behind it, and if, further, fever and severe pain are present, immediate paracentesis is definitely indicated.

* *Prager Medizinische Wochenschrift*, 1900, Nos. 20, 21.

These indications hold, I believe, for the majority of aurists in spite of Zaufal's opinion; but in only a small minority of the cases are the symptoms as clear as this in the early stages. Fever is almost always present in children, rarely in adults, in whom—as a rule, at least—there is only a trifling rise of temperature. Often even this slight rise is absent even when the attack is severe. It is not always possible to come to a definite conclusion as to the presence of secretion in the tympanic cavity from the appearance of the drum. Even a general bulging of the membrane is not necessarily a result of a collection of fluid, but may be caused by a diffuse swelling of the mucous membrane lining the cavity. mm Adh
1/25-

In some cases the tympanic membrane is moist and covered with shreds of sodden epithelium; in others it is dry, markedly reddened, and diffusely swollen. In either case it is impossible to see any sign of bulging outwards. MT Swell
bleb - red
reflex -
ear far

It is often exceedingly difficult to obtain a good view of the drum in young children. The meatus is filled with cerumen and epithelial débris, very difficult of removal even by syringing, which is the best method. When the surgeon attempts to make an examination, his view is at every moment obscured by scraps of epithelium thrusting themselves across the field of vision, and at the same time the little patient becomes at every moment more difficult to manage. Even when at length a view of the tympanic membrane is obtained, everything is on such a small scale that it is sometimes quite impossible to decide with certainty whether there is bulging or not. When, as is the case in the aged, the membrane is thickened, the signs of inflammation are often but slightly marked. The colour is reddish-grey, and the swelling only moderate in amount. Yet these cases are perhaps the most dangerous: the presence of the pus cannot be ascertained owing to the general cloudiness and thickening of the membrane, while, for the same reasons, it cannot make its escape outwards, and is apt to find its way into the internal ear. ear no
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It is necessary to mention here that some aurists recommend catheterization of the tube in acute inflammation of the middle ear, with the object of determining whether exudate is present or not. I am altogether opposed to this method of diagnosis, for, apart from the fact that blowing air under more or less high pressure into the tympanic cavity and against the inflamed drum causes pain to the patient, it irritates the diseased mucous membrane, and it is possible that some of the secretion may be forced by the stream of air into

the mastoid cells. In the earlier years of my practice as an aurist I had the unpleasant experience of discovering that this is not merely a theoretical assumption. I catheterized a patient who had been suffering for some time from acute suppuration in the middle ear. Pain had been absent for weeks; there were no signs of inflammation on the drum; the secretion was moderate in amount. When the patient came back to me on the following day, he complained of severe pain in and behind the ear; the mastoid process was exceedingly tender on pressure. There could be no doubt that the catheterization was the direct cause of the exacerbation of the inflammation, and of its spreading to the mastoid process. I therefore condemn most strongly inflation of the tympanic cavity in acute purulent middle-ear disease, even when the drum is perforated.

How, then, are we to act when the three important symptoms—bulging of the drum, fever and pain—are not present? A general rule applicable to all cases cannot be formulated; each must be considered on its merits. Little as I agree with Zaufal's ideas on the limited usefulness of paracentesis, I am not by any means in favour of performing the operation in every case of acute otitis media with an unperforated drum. In many cases of otitis either no exudate is formed or only such a small amount as can be easily reabsorbed, and these patients will recover, whether treated or not, without perforation of the tympanic membrane. On the other hand, infection of a previously healthy tympanic cavity by the operation of paracentesis is, although extremely rare, not altogether unheard of, since we cannot render the field of operation absolutely aseptic. Further, as Piffel has shown, it is beyond question that in the act of blowing the nose germs may be more easily forced through the Eustachian tube into the tympanic cavity when the drum is perforated than when it is not.

In these doubtful cases, in which a large collection of exudate in the cavity cannot be demonstrated, the surgeon must be guided by the patient's symptoms and by the condition of the mastoid process. If the pain is severe enough to deprive the patient of sleep, immediate paracentesis is to be recommended. The operation is also indicated if the mastoid is tender on pressure, or if the soft parts over it are swollen. On the other hand, if little or no pain is complained of, and if there are no signs of inflammation about the mastoid, expectant treatment is advisable. If the drum shows signs of severe inflammation, the patient should be confined to bed, or at

least to the house, and directed to apply to the affected ear warm or hot compresses of aluminium acetate solution (1 ounce liq. alum. acetat.* to $\frac{1}{2}$ pint of water). If the skin is tender, dry heat is more suitable: bags, 7 or 8 inches square, made of soft linen and filled with heated linseed meal, will be found useful. Under this palliative treatment a very large number of cases of middle-ear inflammation recover, as I mentioned above, without either spontaneous perforation or paracentesis of the drum. If the fluid has already broken through of its own accord, but the perforation is not large enough to provide efficient drainage, so that the signs of retention of secretion (headache, earache, tenderness on pressure over the mastoid, fever) appear, the perforation must be enlarged. The same procedure must be adopted in cases where a paracentesis opening has partially closed up and is no longer large enough for adequate drainage, so that symptoms of retention occur. It is, of course, obvious that immediate paracentesis is called for in these cases if the so-called symptoms of meningeal irritation set in. These symptoms, which can be particularly severe in children, are: partial unconsciousness, convulsions, vomiting and headache. Paracentesis is likewise indicated if signs of pressure on the labyrinth (vertigo, nystagmus) or paralysis of the facial nerve occur. When cerebral complications threaten, paracentesis alone will probably not suffice, but it should always be performed as a last attempt before the larger operative measures are undertaken.

I have nothing to add to the other indications laid down by Schwartze and given above. It is to be noted, however, that in cases of acute or chronic catarrh of the middle ear it is very rarely necessary to make an incision in the tympanic membrane for the purpose of allowing the exudate to escape. As a rule, catheteriza-
tion or politizerization, combined with warm, moist compresses, is sufficient to cause reabsorption of the fluid. The cases in which the exudate forms stringy colloid masses are not often seen. When they do occur, they can only be made to heal satisfactorily by forcing the pathological contents of the tympanic cavity out through the incision in the drum by means of a stream of air blown in through the Eustachian tube.

True!

* Pharmacopœia Austriaca.

The Operation of Paracentesis.

Special preparations are not necessary for paracentesis of the tympanic membrane. It is impossible to make the field of operation aseptic, and we therefore do not attempt to do so. The meatus is, of course, cleansed, and cerumen and epithelial masses are removed by careful syringing and swabbing out with wads of sterile cotton-wool on a wool-carrier (Fig. 1), until a good view of the drum is obtained. For washing out I use a Lucae's hand syringe with a piece of thin rubber tubing over the end. By this means injuries to the meatal walls, particularly liable to occur with restless children, are avoided.

To anæsthetize the membrane I have used the following mixture with success :

Acid carbol. liq.	...	...	...	...	1 part.
Cocaine	} āā	...	...	...	4 parts.
Menthol		...	...	...
Spt. vini	...	...	...	...	20 „

This can be dropped in, or a piece of wadding soaked in it may be placed against the drum. It does not cause absolute anæsthesia, but

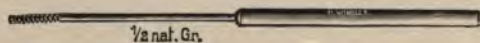


FIG. 1.—WOOL-CARRIER.

diminishes the pain very greatly. This mixture was recommended to me by Bloch, who is satisfied with it after having used it for many years in the University Otological Clinic in Freiburg. Stronger solutions of carbolic acid are inadvisable. I have seen cases of marked erosion of the drum as a result of their use.

To make the operation absolutely painless, a general anæsthetic must be employed. Though rarely necessary in adults, it is often better to induce general anæsthesia in children unless the assistant who holds the child is perfectly reliable. Bromethyl anæsthesia is quite sufficient for the little operation. To administer it a small quantity (10 to 15 grammes for children, 20 to 25 grammes for adults) is poured on a chloroform mask, which is then covered on the outside with waxed cloth and pressed tightly over the mouth and nose. Anæsthesia results in twenty to thirty seconds. It goes

without saying that the instruments must be boiled and the hands of the operator thoroughly cleansed.

For making the incision I use Lucae's paracentesis needle (Fig. 2). The shaft is bent like a bayonet, so that the hand holding the instrument does not obscure the surgeon's view into the meatus. It is easier to hold this needle steady than those which are bent at an obtuse angle. The patient, as a rule, is placed in a sitting posi-

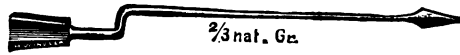


FIG. 2.—LUCAE'S PARACENTESIS NEEDLE.

tion, and his head is, if possible, steadied by an assistant; a child must, of course, be held on the lap of an assistant. The light must be good and the drum well illuminated, and for this reflected daylight rarely suffices. I use mostly incandescent gas-light, but in private practice in the patients' homes one often has to be content with a petroleum lamp. The reflector I always use is that suggested by Lucae, which is held in the operator's teeth (Fig. 3). This may

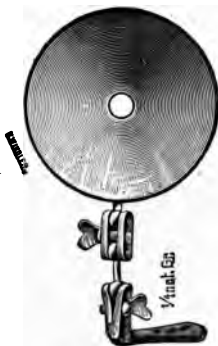


FIG. 3.—LUCAE'S REFLECTOR.



FIG. 4.—LUCAE'S AURAL SPECULUM.

seem unpleasant, but the mirror has many advantages over the one in common use, which is attached to a band round the forehead. Lucae's mirror can be brought nearer to the eye, and remains fixed in whatever position it is placed, so that the constant fixing and altering of the position of the mirror is unnecessary. The mouth-piece is made to fit the teeth accurately from a cast previously taken and the metal parts are of aluminium, so that holding it does

not cause any discomfort. The pressure of the head-band which is so troublesome, especially in summer, is absent. Finally, Lucae's mirror has the advantage that it takes up very little space, and can easily be carried in the pocket in a leather case.

Our aural specula, also suggested by Lucae, are cut off obliquely at the smaller end (Fig. 4), to facilitate their introduction into the meatus. The forceps is bayonet-shaped (Fig. 5).

The incision is made, as a rule, in the posterior inferior quadrant. It is well known that the drum does not lie perpendicular to the



FIG. 5.—BAYONET-SHAPED FORCEPS.

axis of the auditory canal, but is inclined to it in two planes—in the horizontal plane from above downwards and inwards, and in the vertical from behind forwards and inwards. The membrane thus forms an obtuse angle with the upper and posterior walls of the meatus, an acute angle with the anterior and inferior walls. The result of this oblique position is that the posterior half lies nearer to the surgeon's eye and is more easily reached by his instruments than the anterior. To provide efficient drainage the incision must be at the lowest possible point: we need only consider, therefore, whether it is to be in the anterior or the posterior inferior quadrant.

It is difficult to get a satisfactory view of the anterior inferior part of the membrane owing to the angle at which it is placed, and also on account of the projection of the anterior meatal wall; we therefore choose the posterior inferior quadrant.



FIG. 6. — LEFT TYMPANIC MEMBRANE, SHOWING LINE OF PARACENTESIS INCISION.

To make the incision the needle is pushed through the drum close to its edge, and the membrane is then cut from behind and above forwards and downwards (Fig. 6). In doing this the oblique position of the drum must be borne in mind, and the needle must be made to advance towards the median line of the body, as well as forwards and downwards. If the surgeon endeavours to make the cut in a plane perpendicular to the axis of the meatus, the

needle will at first enter the substance of the drum, but later it will not reach the membrane at all, or at most will scratch it superficially.

The position of the incision perpendicular to a radius of the drum is chosen because a wound so made will gape more satisfactorily. In the outer layer of the membrane the fibres are radially arranged, and the edges of the wound are thus drawn apart. There is one mistake into which the beginner is apt to fall—namely, he may incise the posterior wall of the meatus instead of the tympanic membrane. The liability to this error arises from the fact that swelling of the drum often spreads to the skin lining the meatus, obscuring the junction of the two. This can be avoided by good illumination and careful orientation before the operation is begun. If the disease is in the attic, and consequently Shrapnell's membrane and the portion of the drum lying posterior to it are swollen and bulged outwards, the incision must be made through the protruding portion and in the long axis of the swelling.

When operating on the upper posterior quadrant, it is necessary to proceed cautiously in order to avoid injuring the inco-stapedial joint.

In cases of acute middle-ear suppuration which have lasted for some time the incision may heal up quickly, so that repeated paracentesis is called for. To prevent this unsatisfactory state of affairs several surgeons have suggested performing the paracentesis by burning a large hole in the membrane with a small galvano-cautery. This method is, however, not without danger. Even though the drum is driven outwards as far as possible by Valsalva's method at the moment of burning, there is still a possibility that the heat may injuriously affect sensitive parts of the labyrinth wall—for instance, the fenestra ovalis, if it happens to be placed low down and far forwards. I have seen one case in which a sudden and fatal attack of meningitis was probably due to this cause (an autopsy was, unfortunately, not obtainable), and since then I have altogether abandoned paracentesis with the cautery.

If the drum is bulged at one point by the secretion, or if the epithelium is raised like a blister, the incision must be made at this point.

Bezold and Katz have described nipple-like projections of the membrane. In these cases paracentesis, or even a cruciform incision, will probably not be sufficient to allow the secretion to escape; the best method is to remove the whole projection with a snare. I have

already mentioned the possibility of injuring the structures of the posterior superior part of the tympanic cavity—namely, the incostapedial joint and the chorda tympani. Besides these, the bulb of the jugular vein may be wounded in the operation of paracentesis, but only when its anatomical position is abnormal, that is, when it projects into the tympanic cavity and is devoid of bony covering. Several cases of this kind have already been published in the literature. If the surgeon has not had an opportunity of examining the patient before the acute attack, he cannot guard against the possibility of this accident; the hæmorrhage can, however, always be brought to a standstill by packing the meatus with gauze. There is but slight danger of injuring the carotid. This accident can only occur when the paracentesis is made in the anterior inferior quadrant, and even then, as Gruber has pointed out, only when there is caries of the wall of the osseous canal, and the vessel curves strongly backwards so as to lie against the promontory.

After-Treatment and Value of the Operation.

When the incision has been made a narrow strip of sterilized gauze is laid loosely into the ear. Formerly iodoform gauze was used—at least, for the first few days—but I have seen in a few cases severe attacks of eczema as a result of its use, and since no special therapeutic action is to be expected from the iodoform in these cases, I have altogether abandoned it.

No external dressing is used except when there is relatively severe hæmorrhage, and then a small pad only is put over the ear and left in position for twenty-four hours. Generally it is sufficient to fill the external auditory meatus quite loosely with gauze or cotton-wool.

The strip of gauze must be changed as soon as it becomes sodden with the discharges. When this occurs the gauze no longer acts as a wick for drainage, but the secretion stagnates in the meatus and the dressing only serves to block up the natural opening. For this reason also tight packing of the auditory canal is to be condemned. In subsequent dressings the patient or his friends cannot, of course, insert the strip of gauze as deeply as can the surgeon with a forceps and with the aid of a reflected light. It is sufficient, however, if a piece of gauze twisted to a point at one end is pushed into the outer end of the auditory passage as far as it will go without forcing. If the surgeon cannot change the dressing himself, and must leave it

to the patient's friends, he must impress on them the importance of absolute cleanliness, especially the necessity of washing the hands before touching the gauze. In children the flow of secretion is often copious and may easily cause eczema around the ear. This is best prevented by applying boric vaseline to the skin.

I will close this section with a few words on the value of the operation, upon which point some doubt has recently been expressed by Zaufal and his school.

Briefly, Zaufal's views are as follows :

'The retention of secretion in the tympanic cavity does not play such an important part in the causation of mastoid complications as is generally supposed ; other points are much more important, as, for instance, the nature of the infection, the anatomical structure of the parts and the general condition of the patient. Further, the main seat of the disease is in the mastoid process itself, and this must be operated on sooner or later ; making or enlarging a perforation in the drum is as useless as opening only one pocket of a multilocular abscess.'

I admit that in some cases of acute suppurative otitis media the mastoid is seriously involved from the beginning of the attack, and the suppurative process progresses in the mastoid cells concurrently with the disease in the tympanic cavity. It is obvious that even repeated paracentesis will have no effect in these cases ; but they are, fortunately, exceptional.

As a rule, in early cases of acute otitis media we have to deal only with inflammation of the mucous membrane which lines the air spaces and covers the bone, and with a slight resulting periostitis. Now, we see almost daily that these simple inflammations can be favourably influenced by emptying the tympanum of secretion. A patient comes with intense pain and tenderness on pressure over the mastoid. Paracentesis is performed, and on the following day the pain has disappeared. I have seen fairly extensive infiltrations, and even in children small subperiosteal abscesses, disappear after paracentesis. Zaufal considers that these favourable results are due to hot packing, but surely, if we can point to success after success following the operation, we may fairly claim that they are due to it.

It is well known that the most severe pain in the ear, fever, even high temperatures, may disappear under this treatment. I say *may disappear*, for we must not suppose that we shall always obtain this favourable result by paracentesis alone.

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I have observed, especially in children, that pain and fever often decrease but slowly in spite of free drainage, although no mastoid complications occur. These cases may bring discredit on the surgeon, as the parents expect immediate, or at least rapid, improvement after the operation. It is well, therefore, to give a guarded prognosis. Zaufal and Piffel express doubts as to whether paracentesis can ever be the means of saving life; the latter, moreover, states that the drum must in time yield before a suppurative process capable of destroying the bone. In this opinion they probably stand alone. The following case, which I observed in my clinic, seems to disprove their views: A labourer, thirty-three years old, developed otitis media with severe pain, but did not come for treatment until the disease had lasted for three weeks. The drum was moderately reddened and swollen; there was no sign of bulging and no perforation. Paracentesis was immediately performed, and the membrane was found to be thickened; only two drops of pus escaped. In spite of the fact that the result of lumbar puncture pointed to an already existing meningitis, I performed a radical mastoid operation in view of the otherwise good condition of the patient. As might have been foreseen, this last attempt was in vain; the patient died thirteen days after admission. The autopsy showed a purulent meningitis, which had started in the labyrinth. The pus had broken through the annular ligament of the stapes at one point. The thickened tympanic membrane had therefore successfully resisted the suppurative process which had burrowed into the internal ear. Early paracentesis would undoubtedly have saved the man's life.*

Schwartz pointed out long ago that conditions of severe meningeal irritation, especially in children, may be cured by a simple paracentesis.

In spite of all differences of opinion, most aurists are agreed as to the usefulness of paracentesis, and the indications for the operation laid down nearly forty years ago by the pioneer of otology, Schwartz, hold good (with very slight alteration) now, and will hold good in the future.

* In a criticism of the first edition of this book (*Münchener Medizinische Wochenschrift*, 1904, No. 49) Scheibe says that this case does not prove my point, 'because a histological examination was not made, and since we may equally well assume that the pus broke into the labyrinth from an air cell near the semi-circular canal, the fistula in the stapedia ligament being then explained by supposing a secondary perforation of the pus from the labyrinth back into the middle ear.'

slight
stern
Zaufal
Piffel
pain

in connection
with
meningitis

Bier recommends paracentesis in conjunction with his passive congestion treatment* of acute otitis media.

Whether the disease heals more rapidly under Bier's treatment is still doubtful. Stenger and Hanslauer believe that it does, but my own cases, as well as those of Körner and Fleischmann, seem to show that healing is just as rapid when the congestion method is not employed. Moreover, this new method has certain dangers, which I shall discuss when dealing with its use in mastoiditis.

2. THE REMOVAL OF GRANULATIONS AND POLYPI.

Large circumscribed granulations are often formed in chronic, rarely in acute, suppurative otitis media. Polypi owe their origin to some extent to granulations, but the word 'polypus' is only used when the growth is covered with epithelium.

Steinbrügge has made the following classification: †

1. Granulomatous (mucous or round-celled) polypi.
2. Fibromatous polypi.
3. Myxomatous or gelatinous polypi.

Those belonging to the last two categories are much less common. In 60 polypi examined microscopically, Brühl‡ found 47 granulomatous polypi, 8 fibromata, and 5 myxofibromata.

The diagnosis is generally easy: only a very unpractised observer can mistake for a polypus the swollen lining membrane of the tympanum when the drum is altogether absent, or the inflamed drum itself. If inspection alone is not sufficient, a careful and cautious examination with a probe (Fig. 7) will establish the diagnosis.

Even when there is no doubt as to the nature of the growth, the sound should always be used in order to define accurately its point of origin. The polypus generally arises in the tympanic cavity, but may spring from the drum, more usually from its uppermost part. Sometimes it grows from the wall of the meatus, the most common

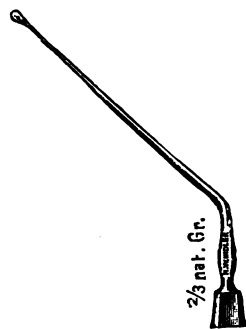


FIG. 7.—AURAL PROBE.

* For the technique of treatment by passive congestion, see p. 59.

† Orth's 'Lehrbuch der speziellen pathologischen Anatomie,' Berlin, 1891.

‡ *Zeitschrift für Ohrenheilkunde*, Bd. xxxviii.

site being close to the upper posterior quadrant of the drum. In these cases the neighbouring portion of the drum will be found to have been destroyed, and the adjacent bone in a carious condition. I have also seen more than one case in which, after perforation of the posterior meatal wall by pus from the mastoid, a polypus protruded through the resulting fistula, completely blocking the meatus. Rare points of origin are the Eustachian tube and antrum. A circumscribed or markedly protruding abscess, or an exostosis in the meatus, may be mistaken for a polypus covered with epithelium on inspection alone, especially if the base is narrowed. Large granulations blocking the meatus and springing from a furuncle which has been opened may be deceptive. Here, again, careful palpation and delimitation with the sound will be sufficient to establish a diagnosis. Lastly, the papillary excrescences of a carcinoma may be mistaken for a non-malignant polypus. If there is any room for doubt, a small portion of the growth should be excised and examined microscopically.



FIG. 8.—WILDE'S AURAL SNARE.

Polypi and large granulations must always be removed. If they are allowed to remain, they may cause serious trouble by preventing free escape of the discharges. Not uncommonly a chronic suppurative otitis media is prevented from healing by the presence of a polypus, and when this has been removed the secretion dries up with surprising rapidity in a few days. This is particularly noticeable when the polypus protrudes through a perforation in the upper part of the drum.

Before beginning the operation, the meatus should be cleansed by syringing. We may attempt to induce local anaesthesia by dropping in a 10 per cent. or 20 per cent. solution of cocaine. The effect, however, will be limited to any of the mucous membrane of the middle ear which may happen to be exposed. Cocaine alone, without the addition of carbolic acid solution, will not anaesthetize the tympanic membrane or the meatal wall. In young children who are likely to be restless, general narcosis with bromethyl (see p. 8) is advisable.

Formerly polypi were removed with forceps, or with instruments

shaped like forceps; nowadays the wire snare is universally employed. I generally use the snare (Fig. 8) suggested by Wilde. The second joint of the operator's thumb is passed through the ring at the lower end of the instrument, while his index and middle fingers rest on the small cross-piece round which the wire is twisted. Bronze wire or annealed steel wire is the most suitable. It should be soft and thin, but at the same time should offer a certain amount of resistance to pressure, so that it may not bend away when it comes in contact with the polypus. The loop is made to correspond with the size of the polypus and is fixed so as to be either in the axis of the instrument or slightly bent on one side. It is then passed as deeply as possible into the meatus, generally along the posterior wall, and by means of slight levering movements is pushed over the polypus until it reaches the base. In doing this care must be taken that the snare comes as little as possible in contact with the sensitive skin lining the bony portion of the meatus. When the snare is well in position the loop is drawn tight and the polypus is extracted with a gentle pull. If the growth is pedunculated, it will tear off at its attachment; if sessile, it is cut through where the wire grasps it. No undue force must be used, for fear of injuring the neighbouring parts. Whether we use an aural speculum or not depends on the position and size of the polypus and on the width of the meatal canal. Large polypi extending nearly to the opening of the meatus may be reached more easily when a speculum is not used.

It is not always possible to remove a polypus at one sitting. The hæmorrhage is often so free that the field of the operation is completely obscured. In these cases we tampon the meatus, but never so tightly that retention of the secretion with its unpleasant consequences might occur; a little gauze in the meatus and a loosely applied absorbent dressing externally are enough to stop the bleeding. After a day or two the remaining portions of the polypus are removed. Both the galvano-cautery and a chromic acid bead are used by aurists for this purpose, but, for the reasons I have given in the section on Paracentesis, I disapprove of the use of the cautery, particularly in the neighbourhood of the fenestra ovalis.

To make a chromic acid bead the point of a bent aural sound (Fig. 7) is heated over a lamp or spirit flame and then plunged quickly into a vessel containing the crystals. A few of these adhere to the instrument which is then held over the lamp again until the acid is evenly distributed over the point. When the bead has cooled

the base of the polypus is touched quickly with it and the meatus is immediately syringed out to prevent erosion of the neighbouring structures. The cauterization must be repeated after a few days, when the eschar has separated, and several times subsequently before the operation can be said to be complete. Owing to the hygroscopic properties of chromic acid the bead must be made each time immediately before it is required for use and, for the same reason, the vessel containing the crystals must not be left uncorked for longer than is absolutely necessary.

Instead of Wilde's snare I sometimes use Beckmann's (Fig. 9) which is rather handier, especially for beginners. The little end-plate through which the wire runs in Wilde's instrument is often inconvenient, and when it happens to be made a little larger than usual it may almost completely conceal a small polypus. In Beckmann's snare the wire runs, as in the modern nasal snares, through a thin metal sheath which is not broadened out at the end; it therefore does not obstruct the surgeon's view.

When the growth is a hard fibroma

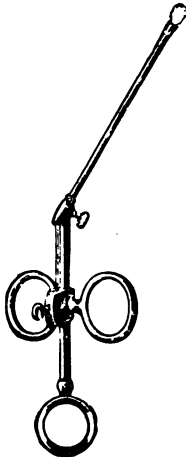


FIG. 9.—BECKMANN'S
AURAL SNARE.

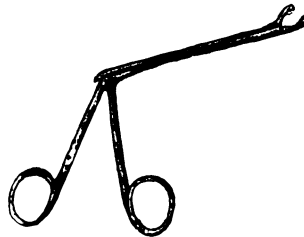


FIG. 10.—AURAL CUTTING
FORCEPS.

removal with the red-hot snare may be indicated. In the operation by this method a certain amount of caution is necessary to avoid injuring the wall of the meatus. For this reason Schwartze recommends that the current should not be sent through the wire until the growth has been firmly grasped. It is important to remember that the snare should only be brought to a red glow, not to a white heat.

Granulations standing on a broad base cannot be properly grasped by the snare, and should be removed piecemeal with a small cutting forceps (Fig. 10).

3. EXTRACTION OF THE OSSICLES.

Indications.

Caries of the malleus and incus is often the cause of persistent discharge in cases of chronic suppurative otitis media alone, or in combination with a circumscribed affection of the attic.

Caries of the handle of the malleus is easily recognized. The process projects markedly into the perforation and is shortened. It presents a gnawed appearance and feels rough on palpation with the sound. If we find, further, above the short process at the upper pole of the drum, a fistula from which pus exudes or through which granulations protrude, we may assume that a carious condition of the other parts of the malleus (namely, of the neck and head) exists (Fig. 30, *c* and *d*).

The presence of caries of the long process of the incus can be determined with certainty in those cases where there is a perforation in the posterior superior quadrant of the drum if at the same time the inco-stapedial joint is not concealed from view by the posterior and upper part of the bony tympanic ring (Fig. 30, *a*, *b* and *e*).

Under these conditions it is possible to see that the incus and stapes are no longer connected together at the joint; the end of the long limb of the incus is thinned and sharpened and lies away from the head of the stapes or may be even altogether invisible, the stapes being thus isolated.

In other cases in which the inco-stapedial joint cannot be seen we may assume with fair certainty that caries of the incus is present if there is a marginal perforation in the upper posterior quadrant coupled with a moderate amount of discharge. A concurrent affection of the attic and antrum can, however, never be excluded. According to Leutert, a small non-marginal perforation in the posterior superior quadrant points to an isolated caries of the long process of the incus.

Operation.

In order to avoid too great congestion of the bloodvessels of the drum it is advisable to avoid cleansing the ear immediately before the operation. The ear is thoroughly syringed twenty-four hours beforehand and the meatus is swabbed out with sublimate solution. It is then filled with sterilized gauze, the auricle and the skin around are washed with soap and water and sponged with ether, and finally a light aseptic protective dressing is applied.

On the following day, when the patient is ready for operation, a sterilized cloth, provided with a hole through which the ear passes, is placed over the patient's head. The operation can be performed under local anæsthesia. To Neumann* of Vienna belongs the credit of suggesting the following efficient method of inducing it :

'The solution, consisting of 1 c.c. of a 1 per cent. cocaine solution plus 2 to 4 drops of Richter's tonogen, is injected through a syringe† bent at an obtuse angle. The point of the needle is plunged into the upper wall of the cartilaginous meatus at a spot $\frac{1}{2}$ to 1 centimetre distant from the commencement of the bony portion, and is then pushed forwards until it is underneath the periosteum of this part. The exact spot for the injection can be easily found by raising and lowering the auricle, when the movable membrano-cartilaginous portion of the meatus will be seen to be sharply marked off by a step-like division from the fixed bony portion. The cutis must be raised by the fluid as far as the drum, otherwise a second injection is necessary.' If the greater part of the drum is intact a circular cut through its margin is necessary in order to free the malleus. An incision is made with the paracentesis needle behind the short process, a blunt-pointed knife (Fig. 11) is then inserted and a cut is made round the membrane close to its attachment. Schwartz recommends beginning the incision at the lower margin of the membrane and carrying it forwards and backwards as far as the malleus, in order that the field of operation may not be obscured by the hæmorrhage. If only a small fragment of the drum is present, it can be freed from its bony attachments by a similar but less extensive incision. The handle of the malleus is now held in position by the tendon of the tensor tympani only, for the attachment between the malleus and incus is normally so loose that they can be separated by simply pulling the former bone. If it should happen that the joint has undergone pathological alteration and is ankylosed, the malleus and incus can be removed in one piece.

To cut the tensor tendon Schwartz's tenotome is used (Fig. 12). This instrument consists of a knife fixed at right angles to a straight shaft, and having one sharp edge and a blunt point. A separate knife for each side is necessary. The instrument, with the cutting edge directed forwards, is inserted into the tympanic cavity in such a manner that the point comes to lie in the attic and is thus

* *Archiv für Ohrenheilkunde*, Band xlv., Seite 67.

† Made by Messrs. Reiner, of Vienna.

concealed from view by the lateral attic wall. When the point meets with resistance above, the instrument is turned forwards round its long axis through an angle of ninety degrees, so that the blade now comes to lie horizontally and is in contact with the upper surface of the tensor tendon. The tendon is then divided by pressing the knife sharply and strongly downwards. If the operation is successfully carried out, a sharp crackling sound is heard when the tendon is cut through. A small blunt hook (Fig. 13) is next passed behind the handle of the malleus in order to make sure that the ossicle is free. For the actual extraction of the malleus I use Lucae's instrument which closely resembles a diminutive lithotrite (Fig. 14).

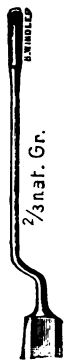


FIG. 11.
BLUNT-POINTED
KNIFE.

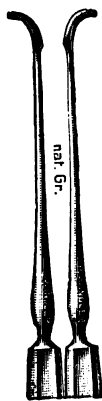


FIG. 12.
SCHWARTZE'S
TENOTOMES.



FIG. 13.
BLUNT
HOOK.



FIG. 14.
LUCAE'S MALLEUS-
EXTRACTOR.

This is inserted behind the short process in such a way that the movable beak comes to lie against the lateral surface and the fixed beak against the median surface of the neck of the ossicle, which is thus grasped firmly when the instrument is screwed up. By raising the handle with a levering movement the head of the malleus can be delivered from behind the lateral wall of the attic. No undue force must be used lest the head of the bone break off and remain behind. If this should occur, the extraction of the fragment must be undertaken with a small hook and may be extremely difficult. Some surgeons (Schwartz, Kessel) pass a Wilde's snare (Fig. 8) round the handle of the malleus and push it up as far as the neck, where the

wire is drawn tight. The extraction then follows as with Lucae's instrument.

Removal of the Incus.—This is often a very difficult operation; sometimes it is impossible, as when the ossicle is dislocated high up into the attic or into the antrum. Many different instruments have been designed for bringing the incus, which in most cases is completely hidden from view by the lateral wall of the attic, within reach. I use, as a rule, a small blunt hook bent at a right angle and having a rounded end. The operator chooses a hook of suitable length (they are made of different sizes), and feels his way carefully in the attic until the knob rests against the upper surface or against the short process of the incus. The whole instrument is then pressed downwards and the long process of the ossicle makes its appearance below the edge of the lateral attic wall. The long process can be seized with a fine forceps and the incus extracted.

The ossicle sometimes falls down of its own accord and comes to lie on the floor of the tympanic cavity. The inco-stapedial joint gives way spontaneously, even if it has not been destroyed by caries. Schwartze divides this joint with the tenotome designed for division of the tensor tympani tendon of the *opposite* side. The cutting edge is allowed to slip down the long process of the incus until it meets the resistance of the joint.

Special incus-hooks, or curettes, have been designed by Kretschmann, Ludewig, Ferrer, Vulpius, Hoffmann, and Zeroni. All these instruments fulfil their purpose well enough when guided by a practised hand; they do not exclude the possibility of

failure nor the danger of dislocating the incus into the antrum. For the surgeon who has not opportunities of practising this operation frequently, Zeroni's curette (Fig. 15) will probably be found the best. In this instrument the blunt hook (Fig. 13) is replaced by a metal loop standing at right angles to the shaft. It is passed from in front over the incus so that the ossicle is caught in the loop, the handle is then raised and the loop, bringing with it the incus, is brought out in a downward and backward direction.

The operation is often rendered difficult by free hæmorrhage.

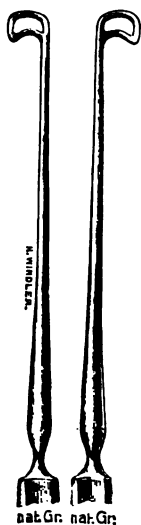


FIG. 15.
ZERONI'S
CURETTES.

The bleeding must be stilled before the surgeon can continue, as the danger of injury to the surrounding parts is very great when the field is not clear. It is sometimes necessary to pack the tympanic cavity and the meatus tightly for a little time. Under local anæsthesia hæmorrhage does not occur.

The chief dangers in the operation are injury to the facial nerve and luxation of the stapes. The facial paralysis disappears, according to Schwarze, in six or eight weeks as a rule. It is caused either by crushing the nerve with the incus-hook or by pressure of extravasated blood. It does not occur unless there is either disease of the wall of the aqueductus Fallopii or else this portion of the bone is fractured during the operation. More dangerous is luxation or unintentional removal of the stapes, either of which gives rise to labyrinth symptoms (dizziness, vomiting, and nystagmus), and may result, as in a case published by Ludewig,* in total deafness on that side. There is, moreover, danger of infection of the labyrinth leading to meningitis.

The chorda tympani is probably always torn—at any rate, when the incus is removed. This injury is of no importance; it causes at most a disturbance of the sense of taste on the portion of the tongue supplied by the nerve.

After-Treatment.

The after-treatment is very simple. As soon as the hæmorrhage in the tympanic cavity has been brought to a standstill and the meatus has been cleansed of extravasated blood, a light packing of iodoform gauze is inserted. An external dressing is not required unless the hæmorrhage is severe. The tampon is left in position for a couple of days. If there is only a moderate amount of discharge, the gauze may be changed once daily, more frequently if a large amount of pus is formed. After seven or eight days the cavity may be syringed out once or twice a day, if necessary, with weak formalin solution (3 drops to $\frac{1}{2}$ pint of boiled water).

Value of the Operation.

Opinions differ on this point. Some surgeons claim that the operation is of the greatest use in cases of chronic suppuration, others are sceptical as to its good results. Of late years I have lost faith in the efficacy of the operation, and perform it but seldom. I find

* *Archiv für Ohrenheilkunde*, Bd. xxxix.

that if the ossicles only are carious, healing can be brought about and the suppuration made to cease by palliative treatment, such as washing out the tympanic cavity (especially the attic) at regular intervals. A dry perforation at the upper pole of the drum or in the posterior upper quadrant near the margin will, of course, remain. I examine frequently a number of patients who have been treated in this way, and I can vouch for the non-recurrence of the symptoms. I admit that in many cases the discharge dries up more rapidly after ossiculectomy, but we must also take into consideration the question of the hearing. If we have to deal with a perforation in Shrapnell's membrane (from which we conclude that the malleus is carious), the rest of the drum being intact, the hearing is generally normal or nearly so. The suppuration, we may take it, is confined to the attic; the remainder of the tympanic cavity is free and there is no pathological change in the parts most important for sound conduction—namely, round the fenestra ovalis and fenestra rotunda. If, however, in such a case the malleus and the tympanic membrane are excised, injury to the hearing is possible or even probable. Further, marked deafness is almost certain to be the result if we follow Schwartze, who recommends removal of the incus as well on the grounds that this ossicle is almost invariably affected when the malleus is carious. In these cases at least I consider that ossiculectomy is unsuitable.

If the suppuration in the attic does not cease even after prolonged treatment (either in the cases just described or in others in which the drum shows the characteristic signs described on p. 71), we may conclude almost with certainty that not only the ossicles, but the walls of the attic, are carious. When there is a marginal perforation in the upper posterior quadrant the antrum may be implicated also. If the ossicles are removed in these cases, better drainage is provided and the attic is made more accessible for washing out, but before healing occurs a long time will elapse and the patience of both the surgeon and the patient will be put to a severe test. Moreover—and I have noticed this in a large number of cases—the hoped-for result may not be obtained at all, especially if the disease has spread to the antrum. After having lost much time, the surgeon may be finally forced to undertake the radical operation.

To sum up, I am in favour of the extraction of the ossicles only in those cases in which the caries is strictly localized to them, and there is marked deafness and stubborn resistance to palliative treatment.

CHAPTER II

OPERATIONS ON THE MASTOID PROCESS

1. HISTORY. 2. WILDE'S INCISION. 3. OPENING UP OF THE MASTOID PROCESS AND ANTRUM: Indications—Preparation for the operation—The operation—After-treatment. 4. TREATMENT OF ACUTE MASTOIDITIS BY BIER'S METHOD.

1. HISTORY.

THE operation of opening the mastoid process to allow of the escape of pus was first suggested and performed by J. L. Petit (died 1750), and by a Prussian military surgeon named Jasser (1776), independently of one another. It was also recommended by the latter for improving defective hearing, but, owing to lack of success and fatal results in several cases, the operation fell again into disuse and was utterly condemned by surgeons. In the middle of the last century Tröltsch and others published reports showing the great advantages of the operation in cases of suppurative otitis media with caries of the mastoid process, but it was really Schwartz* who brought it again into use, thereby laying the foundation-stone of modern aural surgery.

At first trephines or drills were used, but Schwartz pointed out the danger of working with these in the dark and recommended the hammer and curved chisel for clearing out the mastoid and laying open the antrum.

In cases of chronic suppurative otitis media also, surgeons originally contented themselves with this operation, and endeavoured, with but little success, to bring about recovery by syringing from the operation wound through the antrum and tympanic cavity, or *vice versa*, as in acute cases.

Küster recommended removal of the posterior wall of the meatus

* *Archiv für Ohrenheilkunde*, Bd. ii., 1873.

for the opening up of the middle-ear spaces, and Von Bergmann suggested chiselling away the lateral wall of the attic and the neighbouring portion of the posterior meatal wall for the same purpose in operations for cerebral abscesses of aural origin. To Stacke and Zaufal, however, belongs the credit of having introduced and worked out with a definite purpose the methods which bear their names.

2. WILDE'S INCISION.

In the course of suppurative otitis media, whether acute or chronic, periostitis of the mastoid process occurs not infrequently and is recognized by tenderness on pressure and more or less swelling behind the ear. This periostitis is seen but very rarely as a primary affection without preceding inflammation of the middle ear. The operation first suggested by Wilde* and known by his name consists in 'a free incision at least 1 inch long into the periosteum of the mastoid process, approximately parallel to the posterior attachment of the auricle and about $\frac{3}{4}$ inch distant from it, in order to avoid the posterior auricular artery.' In his book 'Surgical Affections of the Ear' (1885) Schwartze strongly recommended 'an early incision reaching down to the bone.' By this method, according to him, the inflammatory process is cut short in many cases, all the more certainly in proportion as the bleeding is free. If the posterior auricular artery is divided in the incision it must be ligatured, otherwise a troublesome secondary hæmorrhage may result.

Of late years aurists have gradually given up Wilde's method. In our clinic it has been altogether abandoned, for the following reasons:

If the middle-ear suppuration has already led to considerable involvement of the mastoid process and the diseased mucous membrane of the pneumatic spaces is producing pus, or if the disease has gone further and led to purulent inflammation of the bone itself or to the formation of a cavity filled with pus and granulations, then a simple incision down to the bone will only bring about recovery in rare cases, whether a subperiosteal abscess has formed or not. The inflammatory process in the mastoid is thus, as a rule, not influenced by the incision and sooner or later the bone must be opened up.

General practitioners, especially those in the country, perform

* 'Diseases of the Ear.'

Wilde's operation fairly frequently and the resulting condition always presents the same picture. The auricle stands out from the head and behind it there is a swelling in which is an incision varying in length. Either the lips of the wound are stuck together and there is a fluctuation in the neighbourhood, or pus oozes out continually. Cases of this kind are sent to us once or twice in each year, and when we operate subsequently we almost invariably find a fistula in the cortex of the mastoid process and typical purulent inflammation in the substance of the bone.

If, on the other hand, the periostitis is the result of a simple inflammation of the bone or of the mucosa in the mastoid cells, it will undergo resolution of its own accord under suitable palliative treatment, without the necessity of undertaking such severe antiphlogistic measures as an incision and the resulting loss of blood. The principles of treatment we shall discuss later in the section dealing with the indications for opening up the mastoid. I should like to make it clear that what I have said above only applies to a true periostitis arising from the disease of the bone. If periostitis is wrongly diagnosed in a case which is really one of infiltration of the skin and abscess formation, resulting from adenitis of the post-auricular glands or from a meatal furuncle, then simple incision will no doubt effect a cure.

Körner* points out that in very young children true empyema of the antrum may find an outlet through the squamo-mastoid fissure and the pus may thus cause separation of the periosteum from the bone. If this abscess be incised recovery may ensue, just as in a case with spontaneous perforation, since the condition present is not otitis but suppuration in the antrum. If, however, there are foci of suppuration in the mastoid process which have resulted from disease of the bone, he believes that Wilde's incision is not a sufficiently energetic form of treatment.

3. OPENING UP OF THE MASTOID PROCESS AND ANTRUM.

Indications.

In acute and subacute suppurative otitis media and their sequelæ I think it sufficient, as a rule, to open up and clear out the mastoid

* 'Eitrige Erkrankungen des Schläfenbeins,' S. 56.

process and to expose freely the antrum cavity. This rule holds good whether we have to deal with disease of the mastoid process itself and a collection of pus in it or in the antrum, or even if signs of an intracranial complication are present. It is to be noted that the word 'acute' is to be understood here in a broader sense than is usual in other branches of medicine. A case of suppurative middle-ear disease may sometimes still be called acute, even when it has lasted for several months. We consider ourselves justified in employing the term as long as the drum presents an appearance corresponding with the acute stage of inflammation—that is to say, as long as the membrane is swollen or reddened, the malleus is invisible and the perforation small.

On the other hand, cases of mastoiditis occur in which the inflammatory signs on the drum are undergoing, or have undergone, resolution, the secretion is but slight in amount and the short process and handle of the malleus have again become visible. Under these circumstances we may conclude that the acute process in the tympanic cavity has run its course and we have to deal only with its sequelæ in the mastoid process.

In some cases of acute suppurative otitis media the radical operation is employed. I shall discuss the indications in the section dealing with the operation.

Considering the indications for opening the antrum, we shall find least difficulty in those cases in which a subperiosteal abscess has formed. The patient presents a perfectly characteristic picture, especially when seen from behind. The auricle is at a lower level than that on the sound side and stands more or less out from the head, according to the size of the abscess. The fold at the attachment of the ear is obliterated, the skin over the mastoid process is tightly stretched and fluctuation is easily demonstrated. In advanced cases (which are fortunately becoming less common every year) the pus may have perforated the skin; a fistula, from which pus oozes, is seen. Occasionally the abscess is not confined to the mastoid region but extends backwards and upwards, raising the tissues of the scalp from the bone. The point where the pus breaks through the cortex of the mastoid process is almost invariably in the fossa mastoidea, $\frac{1}{4}$ to 1 centimetre behind the posterior wall of the meatus, the level varying slightly in different cases. Very rarely the perforation is in the lateral part of the posterior and upper meatal wall. The fistular opening varies in size from a pin's head to a

lentil, soft granulations protrude from it, and pus exudes under pressure. Occasionally the cortex is destroyed for some distance around; in some cases, indeed, the surgeon, on making the skin incision, comes at once into a crateriform hollow in the bone filled with granulations. In other cases, again, in which such extensive abscess formation has not occurred, the cortex is still intact and only a slight discoloration of the bone gives warning of the threatened perforation, or perhaps a drop of pus may ooze out through one or other of the vascular foramina. Not infrequently the pus makes its appearance on the lateral surface of the mastoid process near the apex; this occurs, as a rule, when the terminal cell and the cells around it have become converted into one large cavity, containing pus and granulations. The squamo-mastoid suture, too, which is almost always present in young children, and sometimes persists in adults, offers a favourable path for the advance of the suppurative process. In rare cases the perforation is found immediately above the upper wall of the meatus or near it, anterior to the suprameatal spine. The pus has then found its way in the cancellous bone between the upper and lower layers of the superior meatal wall. These cases are recognizable on inspection by the fact that the abscess or infiltration is confined to the upper part of the mastoid process and lies above and in front of the auricle which is thus displaced rather downwards than forwards.

I have observed that these external signs were particularly well marked in cases in which the drum retained little or no sign of inflammatory change and a perforation of the membrane had not occurred. The patients frequently state that, although they suffered from earache in the beginning, no discharge was noticed. This seems to suggest that the original trouble was a suppurative inflammation of the closed attic and that the pus found its way out directly without reaching the antrum or the mastoid cells. Further evidence in favour of the supposition is furnished by the fact that in most of the cases which have come under my notice no communication with the antrum could be found and this cavity, on being opened, showed no pathological changes. The proof will, of course, only be furnished when a primary acute inflammation of the attic develops under observation in the manner described above, for we must remember that an abscess may be found on the mastoid process itself, there being no communication between the abscess cavity and the antrum.

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Distension and swelling in the neighbourhood of the root of the zygoma, with which œdema of the eyelids is often associated, point to an extension of inflammation into the base of the zygomatic process and into the squamous portion of the temporal. The two layers of the squamoid may be forced apart so as to enclose between them a cavity filled with pus and granulations; indeed, the process may go so far as partially to destroy the inner layer of the bone exposing the dura mater covering the temporal lobe.

If the abscess is at the junction of the mastoid process and the occipital bone and tends to extend to the latter, the perforation will be found at the back of the mastoid. In such cases the pus is at first in the posterior fossa of the skull and finds its way out from there. The mastoid emissary vein sometimes serves as a path for the pus which may thus burrow deeply under the muscles of the neck.

An abscess may be found between the lateral neck muscles if the pus reaches the digastric fossa through the median wall of the apex of the mastoid process (Bezold's mastoiditis). The side of the neck appears swollen and is very tender on pressure. On account of its position underneath the muscles, fluctuation can only be demonstrated in the abscess when it has attained a considerable size. At the time when the pus first breaks through the bone or just before this event, a rigid band of infiltration may be felt, situated deeply and passing from the mastoid to the muscles. This swelling obscures the outline of the bone and prevents the surgeon from inserting the tip of his finger underneath the apex of the mastoid as he can do on the sound side.

This form of mastoiditis is not seen in very young children. Perforation at the point described does not occur, according to Körner,* unless there are large pneumatic spaces at the apex. I have found that mastoids with a large terminal cell and a very thin median wall are particularly liable to this form of perforation.

The mastoid process is but slightly developed in early childhood, and contains no large cavities except the antrum. The anatomical structure of the parts is thus important for the differential diagnosis in doubtful cases. We often see in children gradually increasing swelling and infiltration of the region under the mastoid process with subsequent development of an abscess. If there is at the same time a suppurative otitis media, the assumption that there is some connection between the two seems justified. This is in most cases correct,

* 'Eitrige Erkrankungen des Schläfenbeins,' S. 39.

but the abscess is not always the result of suppurative mastoiditis; it may develop from the adenitis which accompanies, as a rule, otitis media in children.

Having regard to the anatomical points mentioned above, the diagnosis in young children is not difficult; in older children and in adults suffering from inflammation of the glands we find generally that the swelling can be defined above by palpation and does not spread on to the mastoid process. Occasionally it is possible to ascertain that the mastoid itself is not tender on pressure.

If any doubt remains the surgeon must incise the abscess and insert his finger into the cavity to determine whether the apex of the mastoid is bare of periosteum and roughened at any point. If this is found to be the case the incision must, of course, be prolonged upwards and the bone opened up with a chisel.

If a subperiosteal abscess is found over the mastoid or in its neighbourhood an immediate operation is indicated; but this rule does not hold good in the preceding stage of periostitis with infiltration of the soft parts. If a patient comes for treatment with the auricle standing out from the head and a non-fluctuating swelling behind the ear he should be directed to stay in bed and to apply warm or hot compresses of aluminium acetate solution. If the perforation in the drum is small it must be enlarged. I have seen many patients recover under this treatment without further operative measures; indeed, I have several times arranged to operate on the following day, but abandoned my intention owing to a marked decrease in the swelling. It is therefore unwise to open up the mastoid too hastily in these cases, supposing always, of course, that other more severe symptoms are not present.

Periostitis on the mastoid process is thus not a serious symptom, but when it appears in the meatus it must be regarded as a danger-signal from the first. In the course of acute suppurative otitis media or in an acute exacerbation of a chronic attack we can often observe that the deeper part of the meatus becomes narrowed, apparently by a sinking in of the posterior and upper part of its wall. This partial stenosis cannot be confused with that due to otitis externa, for it begins painlessly. Pressure on the tragus or the cartilaginous meatus and pulling on the auricle cause no pain; only direct pressure with the probe is unpleasant for the patient. The narrowing is, as a rule, confined to the inner part of the meatus, whereas in otitis externa the whole of the canal, especially its outer

end, is swollen and concentrically narrowed. The so-called 'sinking' of the posterior superior wall is the result of local periostitis which in turn depends on an empyema of the antrum. It is by itself and without any external symptoms a warning that the cavity must be laid open. The very absence of periostitis of the mastoid process and of tenderness on pressure over it is a further indication for operation. It is impossible to know the exact anatomical structure of the mastoid beforehand, but it may be more or less sclerosed and so allow the pus to pass inwards rather than outwards. Operation is therefore always indicated when the meatal canal is narrowed by apparent sinking in of the posterior and upper wall.

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If the case has progressed so far that the pus has broken in through the posterior meatal wall forming a fistula through which a probe can be passed into the mastoid cells, operation must not be delayed. If there is tenderness on pressure over the mastoid process in the absence of other symptoms, opening up of the bone is, as a general rule, only indicated when this tenderness appears in the later stages of acute suppurative otitis media and persists in spite of suitable treatment (rest in bed, warm stupes, paracentesis). The mastoid is very often tender on pressure in the beginning of an attack of acute middle-ear disease, especially when the discharge does not find an adequate outlet. As a rule, this tenderness disappears after a few days; if it remains unchanged or increases or if it sets in later (perhaps when the otitis media has already lasted some weeks), it is a sign that the pathological process in the bone is advancing. Corresponding to the points at which the pus generally approaches the surface the greatest amount of pain is caused by pressure over the fossa mastoidea (close behind and a little below the upper attachment of the auricle) and over the apex of the mastoid process. Sometimes one of these points is more tender than the other, sometimes they are equally so. In palpating the apex care must be taken not to press *underneath it*, this will cause pain even to a perfectly healthy person.

If the patient is suffering from otitis externa the region behind the ear may be swollen, the auricle may stand out, and in some cases the bone may be tender. Mistakes will be avoided if the surgeon first examines the meatus and observes the inflammation, and then notes that the tenderness on pressure only stretches a little distance backwards on to the mastoid and is most strongly marked at the anterior edge of the process in the neighbourhood of

the meatus. Further, in otitis externa, if the inflammation has not extended backwards and the swelling merely represents a secondary œdema, the surface is found to be doughy and retains the impress of the finger. The question whether an otitis media is present at the same time can only be answered by testing the hearing; even a large amount of swelling narrowing the meatus considerably will not cause as much deafness as will inflammation in the middle ear. If otitis externa and otitis media are both present, it may be exceedingly difficult to decide which of them is to blame for the condition in the mastoid region. An abscess behind the ear may arise from one or the other. If on incision the pus is found to be superficial, the periosteum not raised from the bone, and the cortex of the mastoid itself intact, opening up of the bone is not advisable.

But there are cases in which no symptoms whatever of mastoid complications are seen and yet the operation brings to light a large focus of suppuration and a mass of granulation tissue in the bone. Especially in diabetics (but also in other patients), rapidly extending softening of the bone may occur without concurrent involvement of the periosteum; even the sinking-in of the posterior superior meatal wall may be absent. Only the very abundant flow of purulent secretion, which fills up the meatus almost as quickly as it can be swabbed away, compels the surgeon to suspect the presence of a large pus-producing cavity in the mastoid, for the small tympanic space could not possibly give rise to so much discharge in such a short time.

According to some authors (Körner, v. Wild, Eulenstein) percussion of the mastoid process yields in these cases a useful diagnostic sign—namely, marked diminution of resonance even to the extent of femoral dulness. In a series of cases Körner found that this was the earliest sign of mastoid complications. } 7

The question whether to operate or not is most difficult to decide in cases of acute suppurative otitis media lasting longer than the usual period (more than four to six weeks), but causing the patient no trouble after the primary stage beyond partial deafness and subjective noises. In my opinion it is a mistake to make the indications for opening up the bone depend on the length of time the suppuration has lasted. The duration of the suppurative process depends on causes which are only partially understood and therefore cannot properly be taken into account. I have seen cases in which complete recovery took place without operation after three or four

months' suppuration. It is true that chiselling open the mastoid process is easy, and does not call for any great technical skill, but every patient will be grateful if he can be spared an operation and will prefer to endure his otitis media a little longer if there is any hope of recovery under palliative treatment. The surgeon thus finds himself often in an unpleasant position: on the one hand, even in a case of suppurative otitis media which runs its course painlessly, the possibility of sudden cerebral complications cannot be excluded with certainty, while on the other hand, apart from the difficulty of convincing the patient and his friends of the necessity for an operation, there may be circumstances which render its avoidance desirable. I once treated for acute otitis media a schoolboy who wished to become a naval officer. When the suppuration had lasted ten weeks without any change for the better or worse, I recommended opening up of the mastoid. Owing to accidental circumstances the operation was not performed. From that time the discharge diminished steadily and his hearing finally became perfectly normal. If he had been operated on he would probably have had to give up all hope of a naval career.

Though the surgeon may thus take the risk of postponing the operation in children and young persons, he must on no account do so if the patient is in middle life, say over forty years of age. I have pointed out elsewhere* that, owing to the anatomical structure of the mastoid process at that age, every acute suppurative otitis media which extends to it is particularly dangerous. The reasons I then gave for this statement have been confirmed by observations in a large number of operations. I have always found that osteosclerosis of the mastoid is, as might be expected, much more common in old people than in others. All stages may be seen, from thickening of the cortex of the bone to conversion of the whole process into an ivory-like mass. It is clear that if the outer bony wall of the antrum is very dense, the suppuration will be incapable of producing periostitis on the surface of the mastoid process, but will tend to spread in other directions, where it meets with less resistance. It would appear that the bone surrounding the labyrinth is not affected by the sclerosing process, but rather tends to become more spongy. In favour of this supposition I have the evidence yielded by several autopsies in which it was shown that the disease had made its way around the labyrinth as far as the apex of the petrous pyramid,

* *Berliner Klinische Wochenschrift*, 1900, No. 35.

where it had given rise to purulent meningitis. The proof was particularly striking in two cases in which the suppurative otitis media had practically passed off without causing any grave symptoms when the meningitis suddenly set in.

From this I have learnt to operate on elderly people when the symptoms are not such as would justify interference in younger patients. Even when there are scarcely any subjective symptoms, I am in favour of opening up the mastoid in these cases if the suppuration continues for five or six weeks.

Lastly, I must mention one complication which is rarely seen in acute suppurative otitis media except when it is caused by scarlatina or tuberculosis—namely, facial paralysis. It may be the result of inflammatory irritation of the nerve in its course through the tympanic cavity and will then pass off with the disappearance of the middle-ear disease. It may also be caused by extension of the suppuration in the mastoid to the Fallopian canal and to the nerve, in which case opening of the mastoid is indicated. The question of operation in each individual case will depend on whether other symptoms are present pointing to mastoid complications.

Preparation for the Operation.

The patient having been bathed, the scalp is shaved for a hand's breadth above and behind the ear. It is advisable to cut the rest of the hair short with a clipping-machine, but this is, as a rule, only possible in men and boys. If the patient is a female, the long hair can be held back by a starch bandage passed round the forehead and occiput. The bandage must be applied immediately before the operation so that it may not dry and slip out of position.

The patient is laid on the operation-table in such a manner that the head and shoulders are raised. A sand-pillow, loosely filled, is placed on the movable head part of the table, and on it the head rests so that the ear to be operated on is turned upwards and the face away from the surgeon. Both shoulders lie on the table. The sand is arranged in the pillow to form a thick roll under the side of the neck in order to raise the affected mastoid region as high as possible; the head is held in this position by the assistant in charge of the retractors. If the neck is very short or if the muscles are tense from insufficient anæsthesia, a second assistant may be required to keep the head at the proper angle. For this operation I

have used ether as an anæsthetic almost invariably for the past eleven years. During this period I have only had one case of death under the anæsthetic, the patient being a woman who was in a state of extreme weakness from prolonged septico-pyæmic fever. I have also seen one case of spasm of the diaphragm; the thorax remained fixed in the position of inspiration and, although we succeeded in bringing the patient round by artificial respiration, I thought it well to use chloroform in some subsequent operations on the same patient. I have had no cases of serious pulmonary or bronchial trouble as a result of the ether. I avoid it, however, and use chloroform if catarrh is already present, especially in consumptives; on the other hand, I employ it without hesitation for quite young children and aged patients.

For administering the anæsthetic I use a rubber mask of the form shown in Fig. 16. A piece of cotton-wool loosely wrapped in a



FIG. 16.
ETHER INHALER.

small cloth is pushed into the point of the mask and soaked with ether. The apparatus is at first held at a little distance from the patient's face to allow him to become accustomed to the ether vapour, it is then gradually brought nearer and finally firmly pressed over the nose and mouth until complete narcosis is obtained. Afterwards it is only necessary to hold the mask in front of the patient's face. By this method quiet, easy anæsthesia is secured and the patient is spared all feeling of suffocation at the beginning of unconsciousness. There is sometimes free secretion of saliva necessitating frequent swabbing out of the mouth; this should be done as rapidly as possible, as the patient is apt to wake up if the mask is removed for too long from before the face. True asphyxia, which is often such an alarming accident in chloroform narcosis, occurs very rarely when ether is used. Occasionally the tongue slips backwards and it may be necessary to pull the lower jaw downwards and forwards or even to seize the tongue with a forceps. The stage of excitement is generally imperceptible even in alcoholics. To make sure of avoiding it, it is well to give the patient a hypodermic injection of $\frac{1}{4}$ to $\frac{1}{2}$ grain of morphia half an hour before the operation; morphia is, of course, not given to children.

The ether mask described above has one disadvantage—namely, that a very large quantity of ether is used; the average amount for

anæsthesia lasting half to three quarters of an hour is 120 to 150 grammes.

Both the chiselling open of the mastoid and the radical operation can be performed under local anæsthesia, if general narcosis is contraindicated by the presence of diabetes or advanced disease of the heart or lungs. Neumann* has suggested and developed a method which gives certain and satisfactory results. For opening the mastoid he uses the following mixture heated to the body temperature :

Cocaine solution (1 per cent.)	...	...	5 c.c.†
Adrenalin	...	...	12 drops.
Physiological salt solution	...	...	3 c.c.

It may be as well to mention here the solution used for the radical operation. The ingredients are the same as those given above, but the proportions are somewhat different :

Cocaine solution (1 per cent.)	...	...	7-8 c.c.
Adrenalin	...	...	15 drops.
Physiological salt solution	...	...	5-6 c.c.

The syringe used is that described on page 20. Three injections are first made, one in the region of the fossa mastoidea, the second at about the middle, and the third corresponding to the apex of the mastoid process. The needle must be inserted obliquely down to the bone and then pushed a little further forwards, in order that the fluid may be injected under the periosteum. This is easy on the smooth upper part of the mastoid, but near the apex two or three attempts may have to be made at different points before the periosteum can be penetrated. After the three first injections two more are made to anæsthetize the anterior surface of the mastoid. The needle is inserted at two points, one above the other in the line of the attachment of the auricle, and in a direction parallel to the posterior wall of the meatus. For the radical operation four further injections are made in the four walls of the meatus at the junction

* *Z. f. O.*, Bd. li., Ht. 2.

† Approximate equivalents :

3 c.c.	= 50 $\frac{3}{4}$ minims.
5 c.c.	= 1 fluid drachm 24 minims.
6 c.c.	= 1 fluid drachm 41 minims.
7 c.c.	= 2 fluid drachms.
8 c.c.	= 2 fluid drachms 15 minims.

of the bony and cartilaginous parts. After ten or fifteen minutes, counting from the first injection, the operation can be begun. The presence of a subperiosteal abscess or pus or cholesteatomata under the soft parts of the posterior superior meatal wall render a case unsuitable for local anæsthesia, because the pressure necessary for absorption of the cocaine solution is absent.

With general anæsthesia the skin in the field of the operation is washed as soon as the patient is asleep; if cocaine injection is employed, the cleansing is carried out before the injections are made. The auricle and the whole region surrounding the ear are thoroughly scrubbed with soap and water for several minutes and then washed in turn with ether, alcohol, and corrosive sublimate solution. The meatus must be well swabbed out with disinfectants. The patient is next covered up to the chin with a sterilized sheet; a sterilized cloth is placed over the hair and fixed with a clip at the back of the head. A cloth wrung out of sublimate solution, on which the surgeon can lay instruments used in the operation, is spread on the patient's chest, outside the sterilized sheet and other coverings. Finally, a square sheet, formed of several layers of sterilized gauze, and having a slit in the centre through which the ear passes, is laid over the side of the head, covering the patient's face and the hand of the anæsthetist. It can be fixed with clips to the other cloths covering the patient. Thus only the ear and the mastoid process remain uncovered. For disinfecting the hands I use hot water, soap, nail-brush, alcohol and sublimate solution. The anæsthetist must also disinfect his hands thoroughly, lest he accidentally touch an instrument or the operator's hand.

In spite of the fact that we have to deal in most cases with suppuration, it is impossible to insist too strongly on the most rigid asepsis. The slightest neglect on this point may be followed by serious consequences; apart from severe infection of the wound, the after-treatment, especially after the radical operation, may be rendered more difficult, and healing delayed considerably. For this reason it is advisable that as few persons as possible should be engaged in the operation; with some practice the surgeon will find he is able to do with only two assistants, one to hold the retractors and the other to hand the instruments and dressings. The stopping of the hæmorrhage, swabbing out of the wound and removal of chips of bone can be done by the operator himself. Swabs packed into the wound for temporary stopping of the blood can be

removed by the surgeon or the assistant in charge of the instruments sufficiently quickly to allow of progress being made with the hammer and chisel before the field is again obscured by blood.

The Operation.

The skin incision begins at the level of the upper attachment of the auricle and runs down parallel to the line of attachment, and not more than $\frac{1}{2}$ centimetre distant from it, to the apex of the mastoid process, the position of which should be defined beforehand by palpation. The incision should not, as a rule, extend above or in front of the upper attachment of the auricle; if it does, some fibres of the temporal muscle are divided and the auricle sinks downwards. It may, however, be necessary to carry the incision further forwards than usual if the squamous portion of the temporal bone and the root of the zygoma are affected. In approaching the apex of the mastoid the surgeon must take care that the knife does not slip off the bone and wound the muscles of the neck—an accident which may give rise to troublesome hæmorrhage.

The incision may go right through the skin and periosteum down to the bone, or the soft parts may be divided in layers. The blade of the knife must be held at right angles to the surface of the bone. When a large abscess is present, it is advisable to empty it of its contents through a small incision in order to avoid soiling the surrounding skin more than is absolutely necessary; when the pus is cleared out the incision through skin and periosteum is completed. Bleeding cutaneous or periosteal vessels are picked up in clip forceps (Fig. 17), which are allowed to remain in position until the end of the operation and are held aside by the assistant in charge of the retractors. It is rarely necessary to tie any of the arteries, but if the posterior auricular is large it may be well to put a ligature on it, especially if the clip forceps holding it is in the way. With a raspatory bent at a right angle (Fig. 18), the surgeon next pushes the periosteum off the bone—forwards until the posterior bony meatal wall and the suprameatal spine come into view, backwards as far as the posterior edge of the mastoid process. If the

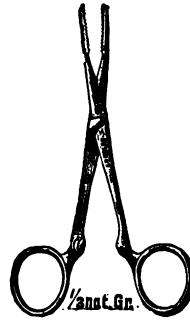


FIG. 17.
ARTERY FORCEPS.

soft parts are separated further back than this the mastoid emissary vein may easily be torn, possibly giving rise to free venous hæmorrhage. Only as much bone should be exposed as is necessary for the operation. I have seen a case in which from undue stripping of the bone a cup-shaped sequestrum formed; and even if this does not occur, the wound will granulate slowly and the after-treatment will be unduly prolonged. Again, for simple opening of the mastoid the soft parts must not be separated so far forwards that the posterior cutaneous wall of the meatus is separated from the bony wall, and, above all, perforation of the cutaneous wall must be avoided. If



FIG. 18.
BENT RASPATORY.



FIG. 19.
RETRACTOR.



FIG. 20.—SHARP TWO-PRONGED
RETRACTOR.

the tendinous attachment of the sterno-mastoid muscle reaches high up over the apex of the mastoid process, the fibres must be divided transversely, separated downwards from the bone with a raspatory and snipped off with scissors. Care must be taken not to leave any shreds behind. They separate off, as a rule, very slowly and delay healing, or may even set up inflammatory infiltration in the neighbourhood of the inferior angle of the wound, which in its turn may give rise to a gravitation abscess. The edges of the wound are held apart with hook retractors. In order to avoid injuring the cutaneous wall of the meatus blunt hooks (Fig. 19) of different lengths are used for the anterior edge of the skin. If the soft parts

are not infiltrated, the posterior edge may be retracted with a two-pronged hook slightly sharpened (Fig. 20); if there is much swelling, I use a three- or four-toothed sharp hook. In order to be able to dispense with one assistant (in my clinic a nurse always holds the retractors), many instruments have been suggested for retracting the edges of the wound. The best of these seems to be Zarniko's catch-hook (Fig. 21).

As soon as the surface of the mastoid has been exposed and the retractors placed in position, a fistular opening or a discoloured patch on the bone should be sought for. If a fistula is found, it may be probed to determine the extent of destruction of the bone. This, however, is not necessary; a few blows with the chisel penetrating the cortex soon make clear the size of the focus of suppuration. If the surgeon decides to use a probe, he should choose a thick one and proceed with caution, otherwise he may perforate the diseased wall of the lateral sinus as I have seen happen in one case. This accident causes serious hæmorrhage not to mention the other dangers which may result from injury to the vessel.

If there is a fistula in the surface of the mastoid, the focus of suppuration is gradually laid bare by chiselling round the opening. When the bone is discoloured we begin in the same way round the patch of discoloration. On the other hand if the appearance of the bone is unaltered, the chiselling is begun in the mastoid fossa (Fig. 22). To mark out the upper limit of the field of operation past which the chisel must not at first be allowed to go, the surgeon looks for the anterior horizontal part of the temporal ridge. This is well marked in most mastoids and can often be felt through the skin; it is completely absent in but a few individuals. If it is absent, we must imagine instead of it a horizontal line drawn backwards from the upper edge of the root of the zygoma. This line is chosen as the upper limit of the field of operation because as a rule the floor of the middle fossa of the skull lies above it. This is, however, not invariably the case. According to Körner,* the floor of the middle fossa, when measured in relation to the meatus

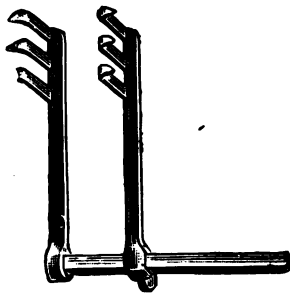


FIG. 21.
ZARNIKO'S RETRACTOR.

* 'Eitrige Erkrankungen,' etc., S. 16.

or the suprameatal spine, is higher in dolicocephalics than in brachycephalics. I have seen the dura at the level of the middle of the posterior meatal wall.

I remember one case in which a portion of the dura the size of a lentil was exposed and on account of its low position and glistening appearance was mistaken at first for the membranous covering of a cholesteatoma. These are, however, exceptions ; as a rule there is no

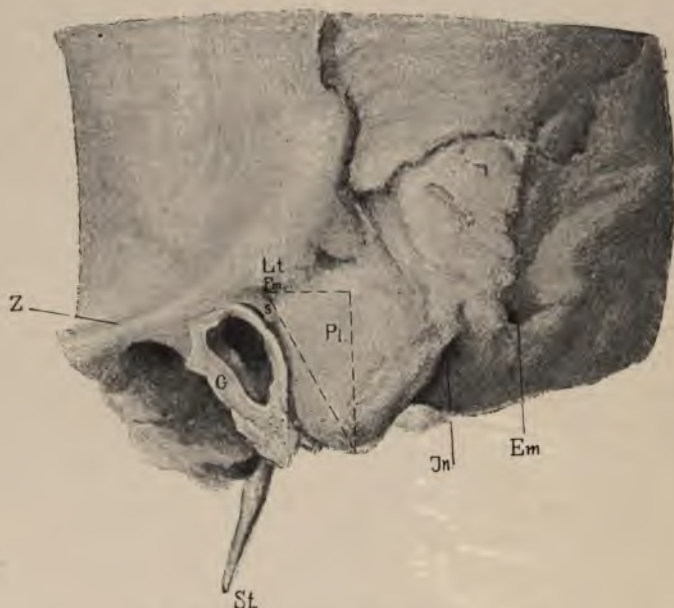


FIG. 22.—TEMPORAL BONE OF AN ADULT.

The interrupted line marks the operation triangle. *Z*, Zygomatic process ; *G*, cutaneous meatus ; *St*, styloid process ; *Lt*, temporal ridge ; *Fm*, mastoid fossa ; *s*, suprameatal spine ; *Pl*, planum mastoideum ; *Jn*, digastric fossa ; *Em*, mastoid emissary vein.

danger of opening the middle fossa if we keep below the temporal ridge. The limit of the field of operation in front is formed by the posterior wall of the bony meatus, or rather by the anterior surface of the mastoid, for the tympanic ring and mastoid process are here inseparably united. If the mastoid possesses a distinct cortical layer, it must be left in connection with the meatal wall. If, however, the outer table cannot be differentiated from the rest of the

bone—as, for instance, when osteo-sclerosis is present—it is necessary to form an artificial posterior wall for the meatus by allowing a piece of the mastoid, about $\frac{1}{8}$ inch thick, to remain. This dividing layer of bone may only be chiselled away when it is diseased or perforated by a fistula. The posterior limit must be defined artificially, and this is best done by imagining a line drawn from the point of the mastoid perpendicular to the temporal ridge produced backwards. Since, however, the apex of the mastoid varies very much, being sometimes blunt and sometimes sharp, this is at best a rough method of defining the posterior limit of operation. Speaking generally, we may take it that it is not wise to insert the chisel further back than 1 to 2 centimetres behind the suprameatal spine

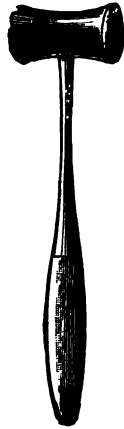


FIG. 23.—METAL HAMMER.



FIG. 24.—LUCAE'S CHISEL.

when working at the level of this process. The field of operation at the beginning can be, therefore, diagrammatically represented by a triangle, of which the base is formed by the temporal ridge or its prolongation backwards, and the two sides by the anterior and posterior limiting lines already described (Fig. 22).

It must be clearly understood that these limiting lines only apply for the beginning of the operation when the outer layer of the mastoid is being cut through. In the later stages the extent of the disease will determine how much of the bone can be spared. As a rule, the bone must be removed farther back than the posterior limiting line described above.

The hammer I use is altogether of metal (Fig. 23); the handle is

short and the head is filled with lead. I have given up wooden hammers because they do not stand repeated boiling. I always use flat chisels as suggested by Lucae (Fig. 24). They are 11 centimetres long and the width of the blade varies from 0·2 centimetre to 1·2 centimetres. The corners of the cutting edge are somewhat rounded off. The operation should be begun with a broad chisel and narrower ones used for the deeper work when smaller pieces of bone have to be removed. Other surgeons employ curved chisels. I cannot speak of these from personal experience, but I am sure that in a hand which is accustomed to them they give as good and certain results as Lucae's do. They are, perhaps, less liable to slip on account of the curvature, but, on the other hand, it is only with a flat chisel that a large, and at the same time thin, shaving can be removed. With the hollow chisel, if the piece of bone cut off is broad—say as broad as the whole curved blade of the instrument—it must also have a thickness corresponding to the radius of the curve, and, conversely, a small piece must be very thin. But in the early stages of the operation the surgeon often wishes to expose the interior of the mastoid quickly, without, at the same time, omitting the caution necessary to avoid injuring a superficial or anteriorly placed sinus, and to effect this he must remove the bone in broad, but thin, pieces. For these theoretical reasons I am in favour of the flat chisel.

To use a chisel accurately requires practice; it is a dangerous instrument in an unaccustomed hand. The surgeon should hold it, to use Schwartz's phrase, 'like a sculptor, not like a carpenter.' To acquire the technique of chiselling it is necessary to practise the operation frequently on the cadaver before beginning on the living subject. If this preliminary exercise is omitted, either the operation will not progress at all owing to the surgeon's nervousness, or he will strike too boldly and endanger important structures. It is quite obvious that the operator must have mastered thoroughly the topographical anatomy of the meatus and its neighbourhood and this knowledge can only be acquired by frequent dissection of the dead subject. The chisel is held between the thumb on one side and the four fingers on the other. During each stroke the instrument is 'checked' by the hand holding it, so that if the posterior or middle fossa is opened unintentionally the blade shall not penetrate sufficiently deeply to injure the dura mater. The dura can only recede to a limited extent from the bone and if the chisel forces it too far the membrane will be perforated.

With short but strong blows splinter after splinter is cut off and thrown out immediately with the chisel or removed with a forceps by the assistant or the operator himself. It is not necessary to cut the pieces of bone completely through; when nearly separated they can be broken off by levering movements of the chisel. Körner strongly condemns this breaking of the bone, but I have never seen any damage result from it when flat chisels are used. The chisel must be placed on the bone, so that it forms as small an angle as possible with the surface; it must never be driven in vertically. Further, the surgeon must avoid as much as possible—at least, at

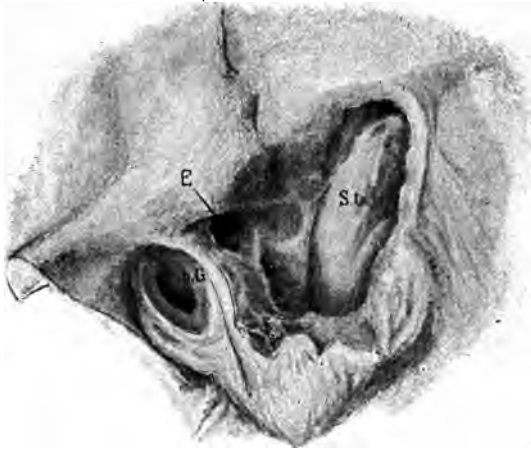


FIG. 25.—LATERAL SINUS PLACED SUPERFICIALLY AND FAR BACK.

Str, Lateral sinus; *E*, entrance to the antrum; *hG*, posterior wall of meatus.

the beginning of the operation—working from before backwards or from below upwards. In chiselling from behind or above the sinus and the dura are not endangered.

The **lateral sinus** runs from the torcular Herophili at first horizontally along the attachment of the tentorium cerebelli in a groove on the occipital bone, which varies in depth and corresponds to the superior curved line on the outside. Just before the petrous bone the sinus bends sharply and takes a direction forwards, downwards and somewhat towards the median line; this last direction becomes more marked at the level of the apex of the mastoid. The sinus opens into the bulb of the internal jugular vein. The mastoid

emissary vein is of special importance in this operation. Its outer opening lies just behind the posterior limit of the mastoid process, and if the skin and periosteum are separated from the bone too far back the vessel may be torn and bleed freely.

The more deeply the sinus grooves the bone of the mastoid process and the further it runs forward, the more superficial and the nearer to the meatus will it lie (Figs. 25, 26, and 27). An anterior position of the sinus is always an unpleasant thing to find. Apart from the danger of injury to the vessel, it may render the operation otherwise very difficult. Of the signs which Trautmann* describes



FIG. 26.—LATERAL SINUS PLACED DEEPLY AND FAR BACK.

Str, Lateral sinus; *hG*, posterior wall of meatus; *Em*, mastoid emissary vein.

The opening of the emissary vein into the sinus is shown.

as being indicative of a sinus placed far forward (deviation of the nasal septum to the opposite side, etc.), I am only able to confirm one—namely, 'the more anteriorly the sinus is situated, the more sharply the planum temporale of the mastoid slopes towards the meatus.'

If the surgeon always takes the precaution of using the chisel from behind forwards, the instrument will slip over the surface of even an anteriorly placed or superficial sinus without causing any injury to the vessel wall. If the chisel is driven from before back-

* 'Leitfaden für Operationen am Gehörgang,' S. 59.

wards it may easily break through the outer layer of bone, compress the sinus against the posterior wall of the sigmoid groove and thus perforate the vessel.

Injuries to the sinus are less commonly inflicted with the chisel than with the sharp spoon. When scraping out a cavity bounded behind by the exposed sinus, or in removing bone from the neighbourhood of its vessel, its walls may easily be perforated when it is diseased and friable, and even when it is healthy may be injured by being caught between the bone and the sharp blade of the instrument. The removal of splinters of bone, which, owing to pachymeningitis, have become adherent to the vessel wall, is at times difficult,



FIG. 27.—ANTERIOR POSITION OF THE SINUS.

Em, Mastoid emissary vein ; *Str*, lateral sinus ; *hG*, posterior wall of meatus ;
Ct, terminal cell.

and can only be safely effected by careful work with blunt hook and forceps. Although this is tedious, and to the unpractised operator anxious work, the surgeon must never on any account omit to remove even down to the smallest scraps of bone from the sinus. When the sinus is exposed, intentionally or unintentionally, small splinters of bone often find their way between its wall and the bony canal in which it lies. One of these pieces may get into such a position that it cannot be seen, its presence being recognized by the fact that the vessel at some point stands a little away from the bone and does not completely fill the aperture. If the vessel wall is cautiously pressed back, the piece of bone will be found

and must be carefully removed with a blunt hook. If such a piece is allowed to remain, it may give rise to pressure gangrene of the vessel wall. I have not actually seen this occur, but in one case under my observation a piece of bone that was almost completely separated from its attachments pressed on the dura, and set up meningitis, which manifested itself a fortnight later and finally proved fatal. This case warned me never to omit careful search for loose pieces of bone on the dura and on the wall of the sinus. It is often a matter of great difficulty to find thin pieces of bone which lie in close contact with the membrane and do not separate it appreciably from the edge of the bone. For this reason it is always well to throw a strong reflected light into the wound when the sinus or the dura is exposed.

When a healthy sinus is opened there is always, even if the perforation is small, a strong rush of blood which can only be confused with the bleeding from an abnormally large emissarium mastoideum. The dark blood wells out in a rapid stream and fills the whole wound in a second or two. To stop the hæmorrhage a large tampon is pressed into the wound and then lifted cautiously until the bleeding-point is found. A small square pad of iodoform gauze is then laid quickly over the hole in the sinus and held firmly in position by an assistant with his finger or the point of an elevator and the operation is proceeded with. If this is done, it will never be necessary to interrupt the operation on account of hæmorrhage from the sinus. Even if the vessel is injured deep down at the bottom of a cavity into which a good view cannot be obtained, it is possible to stop the hæmorrhage by first tamponing the whole wound and then enlarging it by removing more bone until the bleeding-point can be got at directly. If the wound is packed without removal of the diseased bone, granulations and pus from the mastoid, there is great danger of subsequent sinus thrombosis. In dealing with this last affection later on, I will discuss the dangers attendant on every injury, and even on simple exposure of the sinus.

Hæmorrhage from the mastoid emissary vein is rarely as severe as from the sinus. The treatment is similar: a small tampon is pressed against the vessel. As a rule, the pressure may be removed after a short time, the little pad of gauze will remain in position of its own accord.

Whether the surface of the bone is perforated by a fistula, dis-

coloured or unaltered in appearance, it often happens that, when a piece of the cortex is removed by the chisel, muco-purulent or purulent secretion flows out and the opening becomes filled up with soft, slimy-looking, red-brown or pale grey granulations. If the destruction of bone has advanced as far as the dura and the sinus, the pus usually wells out intermittently and often the whole mass of granulations pulsates. The surgeon should in such a case determine by careful probing how much the bone still overhangs and remove the ledge with the chisel or bone forceps. Chiselling is not without a certain amount of danger: it may set up a localized meningitis or may determine the rupture of a pre-existing cerebral abscess into the ventricle. If, however, the bone is so thin that it can be easily cut off with a bone forceps, the use of the chisel will cause but a minimal amount of concussion. The work may, perhaps, be done more quickly with the bone forceps. The best types are the small Lüer's forceps and that suggested by Jansen (Fig. 28).

When the focus of suppuration has been exposed it is cleared out with swabs and a sharp spoon. The granulations are often so soft and so loosely attached to the walls of the cavity that they can be brushed off with a piece of gauze held in a clip forceps. This is the least dangerous way of removing them, but care must be taken not to exercise too much pressure posteriorly for fear of injuring the diseased wall of the sinus if it happens to be exposed. When the mass of granulations has been removed the hæmorrhage, which may be troublesome at first, diminishes considerably, and a view can be obtained of the extent of the destruction of bone and the conditions of the walls of the cavity.

If the suppuration in the bone is of old standing and the walls of the pneumatic spaces have been broken down, a cavity is found, the size of which varies from that of a bean to that of a hazel-nut. The cavity has for the most part smooth walls and is often bounded posteriorly by the sinus. The wall of this vessel is always found in such cases to have undergone pathological changes. While the healthy sinus appears blue or blue-grey, it is here of the same colour as the surrounding parts and can only be distinguished from them by a practised eye. It can be identified with certainty by cautious

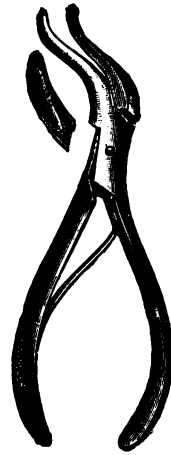


FIG. 28.

palpation with a thick, blunt probe. When the cavity has been thoroughly cleaned out the brownish-red colour of the thickened sinus wall is easily distinguished from the bone. It is either smooth or covered with ragged fibrous shreds which cannot be rubbed off. This, at any rate, is the appearance in a case of ordinary uncomplicated perisinous abscess; we shall see later how the sinus looks when it contains a thrombus. To the median side of the sinus a small strip of cerebellar dura is sometimes exposed. A bulging forwards of the vessel wall, often very slight, marks the division between the two, but they cannot be distinguished otherwise as they are of the same colour and structure. At the upper part of the cavity it is generally possible to find a portion of the dura of the temporal lobe laid bare, and this is; as a rule, also thickened and discoloured.

It is always advisable to expose the diseased membrane and the sinus freely until healthy portions of the tissues are reached, for sometimes the bone is more involved than it appears to be, and pus is found between it and the dura.

The cavity often extends down as far as the apex of the mastoid process. If the terminal cell is well developed, it forms a space filled with pus and granulations which communicates with the main focus of suppuration either by a wide channel or only by a narrow strip of granulation tissue. If the bone has even a slightly suspicious appearance when granulations are seen on the floor of the cavity, the surgeon must on no account omit to open up the terminal cell. Should it be forgotten, the pus may later find its way out among the muscles of the neck.

In some cases a swelling may be observed below the apex of the mastoid and the surgeon finds that he cannot insert the tip of his finger under the process. When these signs are found the median wall of the terminal cell is probably already partially eroded and submuscular perforation threatens.

In Bezold's mastoiditis, or when there is a perforation at another point of the apex in connection with widespread disease of the cortical layer of bone, it is necessary to remove the whole end of the mastoid. This is best done piecemeal with Jansen's bone forceps, the pieces of bone being twisted off or freed with a scissors from the tendinous fibres of insertion of the sterno-mastoid muscle. Any loose fibrous tags which may remain must be carefully pared off with the scissors.

If a gravitation abscess is already present under the muscles, it may be opened separately before the operation on the mastoid is begun; the skin incision is prolonged downwards as far as the infiltration extends and the muscles are separated with a blunt dissector. If the abscess is large it will be easily found by this method, but a small one may be missed. It is therefore better, in order to avoid superfluous searching about in the musculature, to expose first the primary focus of suppuration in the mastoid and to seek for the site of perforation. When this has been identified the point of the mastoid can be removed and the abscess, even if deeply situated, is easily found.

According to the extent of the suppurative process either the muscles may now be split and a large opening left or an incision for the insertion of a drainage-tube may be made underneath the mastoid. The latter method should be chosen, if possible, in order to avoid a large unsightly scar on healing.

There is only one type of suppuration in the muscles in which free incisions are absolutely necessary. I have seen several cases in which, instead of an abscess being formed, the suppuration was intramuscular—*i.e.* in the interstices of the bundles of muscle fibres. Swelling was altogether absent, but when the soft parts were pressed upon pus oozed out from some part of the wound and I was forced to make incisions, some of them reaching even to the middle line. The prognosis in such a case is bad; the patient can only be saved from a fatal septicæmia by following up the pus with long incisions for drainage.

Not infrequently a canal filled with granulations is seen to run along by the lateral sinus from its lower bend towards the bulb of the jugular vein. This canal is formed by the breaking down of the cells which follow the course of the sigmoid groove. If the bone destruction has been going on for some time, the sinus may be exposed at this point and may even contain a clot. The region should be cleared with a sharp spoon, but in doing so the utmost caution is advisable: posteriorly the sinus may be wounded, while if the bone is diseased deeply and far forwards it is possible to injure the facial nerve where it passes between the posterior meatal wall and the sinus. During the operation the face must be carefully watched for twitching.

If a perforation has occurred through the posterior wall of the meatus, it is impossible to avoid removing part of the wall

in order to get rid of the diseased bone. The cutaneous part of the meatus must be spared as much as possible; the edges of the fistula in it must be scraped or excised with a fine scalpel, and if this is done carefully the hole will close completely, leaving no narrowing of the meatus behind. If it is necessary to remove the whole posterior wall as far as the tympanum we may, as Winkler* recommends, form a flap of the posterior cutaneous meatal wall by Stacke's method (*q.v.*), and fix it in the lower part of the operation wound. The retro-auricular opening can be closed later by a second operation.

If the pus has made its way out at the posterior edge of the mastoid process, a condition most commonly found in connection with an extradural abscess in the posterior fossa of the skull, the single skin incision parallel to the attachment of the auricle will not suffice. A second incision at right angles to the first is necessary to find the fistular opening in the bone. On the other hand, the second incision and the resulting scar can be avoided in those cases in which the subperiosteal abscess reaches far back, but the perforation in the bone is in the ordinary situation. When the pus and the soft granulations have been removed the skin becomes rapidly fixed to the bone.

In cases where the disease has spread through the superior wall of the meatus into the root of the zygoma and into the squamous portion of the temporal, it is, as a rule, necessary to extend the skin incision above and somewhat in front of the superior attachment of the auricle. If possible, however, the diseased bone should be removed by working forwards under the skin by reflected light in order to avoid subsequent disfigurement by sinking down of the ear.

A communication exists, as a rule, between the antrum and the diseased cells of the mastoid. Sometimes the bone is found to have been broken down and the antrum is reached without further trouble, or the bone may be softened and filled with granulations, so that it can be easily scraped away with a sharp spoon. Whatever the structure of the mastoid, whether spongy or partially sclerosed, there may be only a narrow strip of granulation tissue leading to the antrum or it may even be impossible to determine the path taken by the otitis from the antrum outwards. Nevertheless, the hollow in the bone must be deepened until the antrum is reached, for it is the primary focus of the suppuration in the cells

* 'Verhandlungen der Deutschen Otologischen Gesellschaft, 1904,' S. 137.

and in the bone of the mastoid process, and must be always freely opened up, even when there is apparently no connection between it and the rest of the diseased bone.

14 An exception to this rule may be made only when the inflammation in the tympanic cavity has completely run its course and the drum has regained a normal or nearly normal appearance, showing that the antrum also has healed. These are mostly cases in which the otitis media has existed for several months before the onset of antrum trouble. Pneumococcal infection is particularly liable to give rise to the late development of suppuration in the mastoid.

Although the opening of the antrum is easy when the bone is more or less broken down, it may be difficult for an unpractised operator if sclerosis is present, and it is just in cases of the latter type that it is specially important to make the cavity accessible and to clear out its contents. For, as we have already seen in the section on the indications for the operation, there may be in these cases sclerosis of the mastoid, while the bone round the labyrinth and as far as the apex of the pyramid is perhaps more spongy than normal. Hence, to prevent the suppurative process from progressing further in the bone, free escape outwards must be provided for the pus.

The antrum can always be found by entering the bone immediately below the temporal ridge and close behind the posterior wall of the meatus, and then working inwards, keeping exactly parallel to the meatal wall. As a rule, the beginner commences either too low or too far back. Even then the antrum may be found if it is large or enlarged by destruction of bone, but in most cases the dura or the sinus will be opened. If, on the other hand, the surgeon begins too high, he may open the middle fossa of the skull. These are unpleasant accidents, but they need not occur if the relationship of the antrum to the posterior and upper meatal wall is borne in mind. To repeat once more, the antrum *must* be reached if we enter the bone close to the posterior wall and keep at the level of the superior wall of the meatus.

When the antrum has been opened a large quantity of pus containing air bubbles often appears, or the blood welling out is mixed with pus. It is advisable to introduce a small curette into the opening which can then be enlarged by rotating the instrument. In doing this the curette must not be held in one hand only, but while the right index-finger is on the back the left index should be

pressed on the front of the shaft, thus exerting a counter-pressure in a direction opposite to that in which the curette is working. The object of this is to prevent the instrument slipping too deeply into the cranial cavity if the friable bone suddenly gives way. A small sharp spoon is used at first and then larger sizes in turn until the antrum is fully exposed to view. If the bone is very hard, the chisel must be used.

That it is really the antrum which has been opened can generally be judged from the size of the cavity, the depth at which it lies and its relation to the posterior meatal wall. It is certainly the antrum if a smooth ivory-like piece of bone is seen in the lower anterior part of the cavity. This is the ridge of the horizontal semicircular canal, and is generally easily distinguishable from the porous bone exuding blood which surrounds it. Sometimes it cannot be seen immediately, owing to the hæmorrhage or to its being covered with soft granulations.

A fine probe, bent at a right angle, or a small blunt hook with an olivary end, may also be used to find the situation of the antrum. If the point of the instrument slips into an opening in the anterior wall of the cavity and meets with resistance when it is drawn outwards, the opening must be the aditus. The probing must be carried out as gently as possible to avoid dislocating the incus, the short process of which is attached just below the ridge of the horizontal semicircular canal (Figs. 37, 38 and 40).

When the antrum has been opened up, it must be thoroughly cleaned out. In most cases it will be found to be enlarged owing to disease of its bony wall. The diseased bone must be removed with the chisel or sharp spoon; every granulation must be carefully scraped away. The surgeon should next ascertain whether the roof of the cavity has been broken through, exposing the dura, and if so what condition the membrane is in. The surface of the dura should be further examined for adherent splinters of bone and raised up cautiously all round to determine whether pus or pieces of bone lie between it and the skull.

A thorough examination of the whole wound cavity finishes the operation. The hæmorrhage has now considerably diminished, and it is perhaps possible to discover here and there a small mass of granulations which has previously been hidden from view by the blood. Even the smallest piece of granulation tissue must be removed and traced to its point of origin, otherwise it may become a

source of new danger. In one case of mine an attack of meningitis to which the patient succumbed set in several weeks after the operation, although the condition of the wound was perfectly satisfactory. The autopsy showed that a small focus of granulation tissue had been overlooked, and from this a narrow canal filled with granulations led into the middle fossa of the skull. The meningitis had started from the corresponding point on the dura. Ordinary

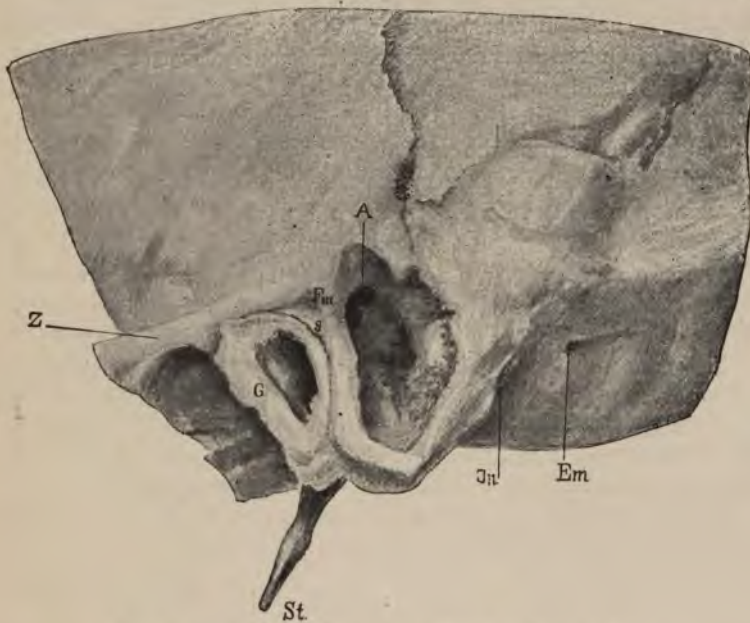


FIG. 29.—THE SAME TEMPORAL BONE AS IN FIG. 22.

The mastoid process and antrum have been opened up. *A*, Mastoid antrum; *Z*, zygomatic process; *G*, cutaneous meatus; *St*, styloid process; *Fm*, mastoid fossa; *s*, suprameatal spine; *Jn*, digastric fossa; *Em*, mastoid emissary vein.

diffused daylight is, as a rule, not strong enough for a proper examination of the operation cavity. As soon as the antrum has been opened, concentrated reflected light must be used. In the radical operation, to be described later, artificial light cannot be dispensed with. In my practice I use an ordinary electric forehead lamp.

When the operation is finished the whole wound is loosely filled

with iodoform gauze, a small strip being gently pushed into the antrum. Tight packing must be avoided; even when there is hæmorrhage from the sinus it is unnecessary if the directions given above are followed. If the tampon is too firm it may cause retention of the discharges and necessitate changing the dressings sooner than is desirable for rapid healing of the wound. When the wound has thus been loosely filled with gauze the clip forceps are removed, and a further layer of iodoform gauze is then placed on the edges of the skin. The hæmorrhage even from the larger vessels now ceases as a rule; in a few cases only the posterior auricular artery must be ligated. All unnecessary swabbing of the edges of the wound must, however, be omitted, lest the bleeding should be started afresh. Partial stitching up of the wound at its ends is advisable only in exceptional cases, and never unless the skin is certainly free from inflammatory change. In my practice I never think of inserting stitches unless the incision has been begun very high up and a large part of the temporal muscle divided. It is always dangerous to close the lower angle of the wound; retention of discharges is almost certain to result and a gravitation abscess is a very possible sequel.

The meatus is next cleansed and loosely filled with a strip of iodoform gauze to prevent decomposition of the secretions which form during the first few days. The skin around the wound having been thoroughly washed of blood, the dressing is completed. In putting on the bandage care must be taken that the auricle is not bent forwards, but lies in its natural position on a thin pad of gauze.

After-Treatment.

The first dressing remains in position for a week unless fever or severe pain sets in. A moderate rise of the temperature up to 100° F. or a little more on the evening of the day of the operation or on the second day need cause no alarm. It is specially liable to occur if the operation has lasted a long time, and is less common after simple opening of the mastoid than after the radical operation for chronic otitis media. This temporary slight pyrexia must be the result of peculiar conditions of absorption, and is doubtless due to the fact that in the frequent swabbing of the wound germs of slight virulence are regularly 'wiped into' the bone. In earlier days it would have been described as 'aseptic wound fever.' A marked rise of temperature or one that lasts for some time necessitates

redressing of the wound. If fever was present before the operation, it will, as a rule, disappear either at once or gradually. If the temperature remains at the same height, something is probably wrong.

To loosen the dressings, which often stick very firmly to the surface of the wound, a 3 per cent. solution of hydrogen peroxide is useful. It should be sprayed on from a sterilized syringe and the resulting froth must always be sponged off before the next portion of the packing is removed. By this means the re-dressing of the wound is made more difficult and slower, but much less painful for the patient.

If the operation has been carried out aseptically, the wound should present the following appearances on the eighth day: The walls of the cavity are covered with fresh red granulations to which the gauze adheres fairly firmly. The secretion being small in amount, it has not soaked deeply into the gauze. The strip in the meatus is somewhat discoloured from the discharges, but is now dry, showing that the suppuration in the tympanic cavity has ceased.

The cavity should be quickly refilled with gauze; otherwise the blood which continues to ooze out must be swabbed away, and there is danger of infection at every touch. A wound which was at first aseptic but has been thus secondarily infected presents a very much altered appearance after having been dressed two or three times. The surface is no longer clean; the walls secrete freely; and instead of the fresh red, even granulation surface, we find soft, flaccid granulations, reddish-grey in colour and bathed in thin pus.

If the condition of the wound is good, the second dressing is left on for four or five days and the third for two or three days. The patient must stay in bed until the end of the first week.

If suppuration continues from the middle ear after the operation, the antrum must be kept open until the discharge ceases. The drain must consist of a small strip of gauze loosely laid into the antrum; a tight plug would cause retention of secretion in the tympanic cavity. The gauze filling the whole wound must also be inserted quite loosely. The beginner easily falls into the error of plugging too tightly in his endeavours to fill out every corner and depression of the wound accurately. It is true that it is necessary to do so, but it can be managed without pressing in the gauze.

Tight packing mechanically prevents the wound from diminishing in size, and thus delays healing. Further, instead of the cavity becoming filled with granulations over which cicatricial tissue grows from the sides, the epithelium makes its way over the edges and a deep hollow is left behind the ear. It must be understood that this last unpleasant result cannot be altogether avoided, even when the gauze is inserted quite loosely; traces of the operation must remain and the scar will be deep and extensive in proportion to the amount of bone destroyed and the size of the wound cavity. The progress of healing also varies much in different individuals. In one patient the wound fills up quickly; in another there is but slow progress made in the formation of granulations: they look unhealthy, and the surgeon may be glad if the wound can be brought, after months of treatment, to heal with a deeply indrawn cicatrix. In a few cases I have seen epidermis growing in slowly from the edges over the trough-like hollow in the mastoid, only to be cast off several times before it finally formed a firm scar. Winkler* mentions a case in which the opening in the bone altogether refused to heal. A patient of mine, a lady about thirty years old, who had lived in the tropics and had suffered severely from malaria, retained after the operation a dry fistula leading into the antrum. Gerber† observed in an eight-year-old child that the cavity failed to fill with newly formed bone, and when healing was complete, the sinus and dura were covered only by epithelium.

I have not tried filling up the hollow with paraffin and stitching the skin over it as has been carried out by Politzer, Hoelscher, and others.

If nothing occurs to delay healing, the cicatrization will be completed in four to eight weeks.

In applying the bandage I always put some turns round the neck and under the lower jaw. Körner‡ has strongly recommended a method of bandaging which leaves these parts free, but I cannot approve of it. It has doubtless some advantages and is pleasanter for the patient, but it allows him, if he feels itchy in the neighbourhood of the wound, to insert his finger easily under the dressings in order to scratch the part. This will always be done, in spite of the strictest prohibition, by unintelligent patients, especially by children.

* 'Verhandlungen der Deutschen Otologischen Gesellschaft, 1904,' S. 144.

† *Archiv für Ohrenheilkunde*, Bd. lxiii., S. 134.

‡ 'Eitrige Erkrankungen,' S. 22.

I have observed more than once in the course of the after-treatment the occurrence of erysipelas which, without the slightest doubt, was due to this cause.

An unpleasant accident after the operation must be mentioned here—namely, iodoform eczema. Every now and then one comes across a patient who finds the drug irritating. Severe itching, beginning soon after the operation, calls attention to this idiosyncrasy. In such cases the dressings must be changed immediately in order to get at the disease in an early stage when removal of the irritant will be sufficient to bring about healing. If the eczema has progressed further and is ‘weeping,’ zinc oxide or zinc ointment must be applied. In the later dressings only sterile gauze should be used, or the new preparation, vioform gauze, may be tried. This has not as strong an antiseptic action as iodoform, but is the best substitute. I do not think that iodoform should be altogether given up in spite of its disadvantages. In these operations, in which the purulent secretion is spread and rubbed by the frequent sponging over the whole wound surface, it is quite invaluable.

Before closing this section a few words must be said about the so-called cicatricial abscess which may be a sequel of the mastoid operation. Some time after the suppuration has ceased and the skin wound has cicatrized the scar may become intensely red, swollen and painful. If it was previously indrawn it will now be raised out beyond the level of the surrounding skin. The inflammation spreads finally over the whole neighbourhood, including the auricle, and leads to the formation of an abscess. The cause is probably in most cases infection through an abrasion of the scar due to too vigorous washing. Sometimes a small sequestrum sets up suppuration in the newly formed tissue; more rarely it is a question of a fresh acute middle-ear suppuration finding its way quickly to the surface. In cases of this last type a thorough scraping out of the old operation cavity must be undertaken; otherwise opening the abscess and emptying it of its contents is sufficient.

4. TREATMENT OF ACUTE MASTOIDITIS BY BIER'S METHOD OF PASSIVE CONGESTION.

According to Bier, the indications for opening up the mastoid are very much limited since the introduction of his method of passive congestion. He believes that if hyperæmia is induced in

the head, acute mastoiditis will be cured without operation or, at any rate, without opening up the bone. The cases published by his assistant Keppler* seem to support this view; they were all sent to Bier's clinic for operation, but recovered without it. Our results in Lucae's clinic were not so brilliant; operations had to be performed in nine cases out of fifteen.† Bier‡ believes that we should have obtained better results if we had awaited the publication of his cases, and states that we operated on indications which he does not recognize as sufficient. This reproach is applicable, if at all, only in my case of Bezold's mastoiditis which he mentions; in the others no experienced aurist would have waited longer. I am convinced that no surgeon will take on himself the responsibility of further postponing operation when, after a trial of the new method lasting two or three weeks, he sees no local improvement and a continual increase in the temperature. In one case which seemed to promise favourably at first, but in which later on acute symptoms of still greater violence appeared, we employed congestion for thirty-two days, until at last the temperature rose to 103·6 F. and vomiting and vertigo set in. Further, one operation was not sufficient in this case and the final recovery was delayed for a considerable time. In another of my cases passive congestion was only kept up for four days. Vomiting and vertigo set in and when I operated I found an extradural abscess in the posterior fossa of the skull. In the end the patient died of thrombosis in the bulb of the jugular. There can be no doubt that the delay of four days was harmful in this case. Any surgeon who has met with cases like these is surely justified in being somewhat sceptical as to the value of the congestion method in mastoiditis. Lack of technical skill cannot fairly be suggested as the cause of these unsuccessful results. Similar results to ours were published from Politzer's§ and Schwartz's clinics.||

* *Zeitschrift für Ohrenheilkunde*, Bd. 1., Ht. 3.

† 'Verhandlungen der Deutschen Otologischen Gesellschaft, 1905.' Of the cases then published which were still under treatment, one had to be operated on after trial of the congestion method for several weeks.

‡ 'Hyperämie als Heilmittel,' vierte Auflage, 1906, S. 368.

§ 'Fleischmann, 'Über die Behandlung eitriger Mittelohrerkrankungen mit Bierscher Stauungshyperämie' (*Monatschrift für Ohrenheilkunde*, vierzigster Jahrgang, Ht. 5).

|| Jsemer, 'Klinische Erfahrungen mit der Stauungshyperämie nach Bier,' etc. (*Archiv für Ohrenheilkunde*, Bd. lxxix., Ht. 1, 2).

Stenger* had more success with a different kind of congestion—namely, cupping—and his conclusions are confirmed by Hasslauer.† The operative measures in his methods are, as we shall see, more extensive; the bone is exposed and the antrum opened. I think that, having regard to the small number of cases as yet published, it is not possible to decide whether the hyperæmia has any real influence on the course of the disease.

Aurists, then, cannot join in the chorus of praise which has greeted the method of treatment by passive congestion. To Lexer's‡ misgivings, which apply for the whole body, there are joined special local objections to its use in diseases of the ear. No two mastoids are exactly alike and it is impossible to tell from outside whether the process has a thin cortex and large cells or is compact or sclerosed. In the first type the destruction of bone progresses rapidly and the pus makes its way soon to the periosteum; in the other kind it does not reach the surface at all, but makes its way insidiously towards the interior of the skull, so that in many cases the first symptoms of an intracranial complication set in with startling suddenness. In such a case it is impossible to tell from outward signs whether or no the congestion treatment is checking the harmful advance of the suppurative process—in fact, it perhaps hinders the diagnosis by relieving the pain and thus removing the one sign on which we can rely.

Bier's case of cerebral abscess§ shows how fatal the new method can be. On the patient's admission the indications for operation were present. Besides tenderness on pressure over the mastoid, there was a stinking purulent discharge with headache and nausea. The possibility of brain abscess was considered. Passive congestion was employed for four days. The symptoms diminished in intensity and the patient was allowed to go about. Then there was a sudden change for the worse; the patient collapsed and the pulse became weak. The operation brought to light an abscess in the temporal lobe and death ensued two days later. It must be admitted that this was a case of chronic suppurative otitis media, for which con-

* 'Die Biersche Stauung,' etc. (*Deutsche Medizinische Wochenschrift*, 1906, No. 6).

† 'Die Stauungshyperæmie,' etc. (*Münchener Medizinische Wochenschrift*, 1906, No. 34).

‡ 'Zur Behandlung akuter Entzündungen mittelst Stauungshyperæmie' (*Münchener Medizinische Wochenschrift*, 1906, No. 14).

§ *Loc. cit.*, S. 365.

dition Bier himself does not recommend his method in the first instance, but it is beyond doubt that the same unfortunate series of events might happen in a case of acute otitis. It is not always possible to diagnose an intercranial complication with certainty before the operation; the appearances on opening up the bone are often the first sign that such exists. It seems to me, therefore, that in the case under consideration the cerebral abscess should have been found on the first day of treatment.

Bier requires also when his method is used that the pus shall be allowed to escape. He recommends paracentesis and the opening of subperiosteal abscesses. But what is to be done with the pus which often collects in large quantities in a cavity formed by breaking down of the bone, without giving rise to any external signs? The surgeon cannot allow this pus to escape because he is unaware of its presence; the thickened cortex of the mastoid prevents it from making its way towards the surface. If the method of passive congestion is used, there is nothing to tell us whether the process in the interior of the mastoid is being checked by the treatment or if the suppuration is laying bare the sinus more and more, with continually increasing danger of thrombosis. Perhaps a knowledge of the condition of the interior of the mastoid is, in Bier's view, unnecessary, for he states that he cannot decide from the few cases he has seen whether under his treatment sinus thrombosis and cerebral abscess demand special precautions. I am very strongly of opinion that, if these complications are present, treatment by passive congestion is quite out of the question.

In his recent work, '*Lehrbuch der Ohrenheilkunde*,' Körner points out another danger of Bier's treatment. In discussing the cases of mastoiditis in which the pus finds its way out through the bone (*stadium fistulosum*) and then apparent healing takes place after the closure of the fistula, although the discharge from the ear continues, he says: 'Such apparent recoveries are well known to every aurist; recently they have been seen to occur as the result of Bier's congestion treatment. They are exceedingly dangerous because the hidden focus of disease may at any time, although perhaps not for many years, become freshly and violently active. The pus may then perforate the bone outwards in some instances, but more often it travels inwards, setting up localized meningitis or one of the other intracranial complications.'

From what has been said, it is not to be wondered at that aurists

in general are opposed to employing congestion for suppurative otitis media. This opinion found expression at the last Otological Congress, but I believe that it is unwise to pronounce a definite judgment at present. On further investigation the treatment may be found to be useful in certain types of the disease. Perhaps bacteriological research will provide some definite points of indication. In any case only an experienced aurist is qualified to work out the subject, and his results alone can be taken as a standard in coming to a decision on the merits of the method. According to Körner, some of the so-called successes obtained by non-specialists depend on a wrong diagnosis, the swelling of the periosteum (which is by no means rare in the early stages of acute suppurative otitis media before perforation of the drum) being mistaken for a sign of disease of the bone.

As I have already stated, in publishing our results from Lucae's clinic, the cases which seem best adapted for a further trial of the method are those in which a subperiosteal abscess has formed or infiltration of the soft parts over the mastoid has occurred. The pus can be allowed to escape and there is thus some security against unseen progress of the suppurative process inward. But even in these cases the greatest caution is necessary. If the local and general conditions do not soon show improvement, the surgeon should not hesitate to go back to the old and certain method of operation before the patient has been exposed to grave danger.

In the technique of Bier's method I follow his recommendations exactly. A piece of garter elastic 2 centimetres wide (1 centimetre for children) is covered with a piece of soft bandage and placed round the neck. It is provided at the ends with hooks and eyes so that it can be tightened or loosened at will. According to Bier, the proper amount of congestion in the head is attained when the face appears somewhat swollen or bloated. The congestion is kept up for from eighteen to twenty-two hours, as a rule.

Most patients find the elastic uncomfortably tight only at first; later they do not notice it at all. The decrease in pain was not so well marked in our cases as in those reported by Bier, in one headache was added to the previous symptoms. On this point observations similar to ours were made in Politzer's clinic.

With the progress of recovery the duration of the congestion is shortened. Bier warns us, however, that if the elastic is left off too soon a relapse is very liable to occur.

'dangerous' one, involving suppuration in the bone. We must also look on the perforation as marginal when practically nothing remains of the drum at all, or only a small fringe of its anterior part (Fig. 30, *b*). The characteristic point is the exposure of the tympanic ring at the part where the posterior and upper quadrant of the membrane should be attached to it.

We must, then, conclude that there is disease of the bone in the antrum when the perforation is in the posterior superior quadrant and the drum appears detached from the annulus tympanicus, while the annulus itself perhaps presents a 'gnawed' appearance or is covered with granulations. The diagnosis in such a case is confirmed

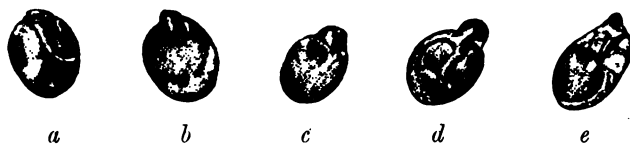


FIG. 30.—MARGINAL PERFORATIONS OF THE DRUM. (SOMEWHAT ENLARGED.)

- a*, Perforation in the posterior superior quadrant, exposing the inco-stapedial joint. *b*, Complete destruction of the membrane. Nothing remains of the malleus but the head which is partially exposed. The descending limb of the incus is somewhat sharpened by caries. The tendon of the stapedius is seen. *c*, Perforation at the upper pole. Shrapnell's membrane and part of the lateral attic wall have been destroyed; the head of the malleus is exposed. *d*, Perforation at the upper pole with partial destruction of the lateral wall of the attic. The head and anterior ligament of the malleus are exposed. *e*, Perforation at the upper pole and in the posterior half of the drum. The neck of the malleus, the inco-stapedial joint and the hollow for the fenestra rotunda are exposed. The malleus is adherent to the promontory; chalky deposits in the anterior part of the drum.

if there is much discharge and the pus flows out quickly from above and behind after all visible secretion has been swabbed away.

It is, of course, possible that there may be at the same time caries of the two larger ossicles and of the attic wall.

When the perforation is sufficiently large—especially if the tympanic ring and a part of the lateral attic wall are destroyed—it is possible to see the inco-stapedial joint (the long process of the incus being either intact or altered by caries), and the tendon of the stapedius muscle (Fig. 30, *a*). Sometimes the descending process of the incus is absent, exposing the isolated head of the stapes; sometimes it is only shortened and thinned, leaving a

distinct space between it and the smaller ossicle. In other cases, again, the head of the malleus and the body of the incus lie more or less exposed and have a gnawed appearance. Thus, the most varied pictures may be observed from the small perforation above and behind which does not expose the structures in the tympanic cavity, to complete absence of the lateral attic wall with destruction of the ossicles.

If inspection is not sufficient to make clear the position and extent of the disease, a blunt probe may be cautiously introduced through the perforation in order to feel for roughening of the bone. The surgeon should, however, beware of a too free use of the probe. Apart from the fact that the patient suffers pain when the instru-

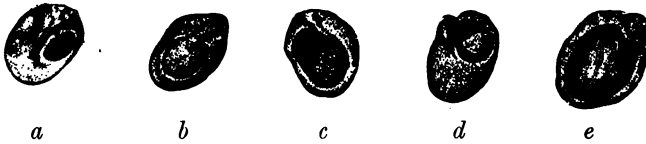


FIG. 31.—NON-MARGINAL PERFORATIONS OF THE DRUM. (ENLARGED.)

a, Perforation in the anterior superior quadrant. *b*, Kidney-shaped perforation in the lower half of the drum. *c*, Large oval perforation. The ostium of the Eustachian tube is visible. *d*, Non-marginal perforation in the posterior superior quadrant. The handle of the malleus is indrawn and lies horizontally. The short process projects like a beak. Shrapnell's membrane indrawn; posterior fold seen. *e*, Almost complete destruction of the drum; a narrow border still remains. The handle of the malleus has been destroyed. The inco-stapedial joint and hollow for the fenestra rotunda are seen.

ment is unskilfully introduced, it is certain that from frequent touching and feeling part of the bone may be artificially laid bare and finally a roughened condition may be simulated. The surgeon must also remember that he is working in the neighbourhood of the stapes; if it is touched with the probe an attack of vertigo may be induced.

A perforation in Shrapnell's membrane is characteristic of isolated disease of the attic and head of the malleus (Fig. 30, *c*).

The Attic.—It is, as a rule, a matter of great difficulty for the beginner to understand rightly the position and structure of the attic, which is, from a surgical point of view, the most important part of the tympanic cavity. Matters are made worse by the complicated descriptions in some text-books, and it seems advisable

to give here, as I am accustomed to do in my lectures, as simple an account of the space as possible. The description is founded on that given by Merkel in his handbook of 'Topographical Anatomy.'^{*}

An imaginary horizontal plane laid through the upper pole of the drum, at the point where Shrapnell's membrane is attached to the temporal bone, will divide the tympanic cavity into an upper and lower portion; the upper part may be compared to the interior of a dome which overtops the cavity of the tympanum. The bodies of the two larger ossicles—the malleus and incus—which stand more or less perpendicularly to the tegmen, divide this dome-shaped space into a median and a lateral half (Fig. 32). The former has a broad communication with the rest of the tympanum and is of no



FIG. 32.—THE ATTIC.

K, Attic; *A*, antrum; *M*, malleus; *I*, incus; *Ch*, chorda tympani; *Tr*, tympanic membrane; *C*, internal carotid artery.

further interest; the lateral half, on the other hand, is an almost completely closed space—the recessus epitympanicus or true attic. This space has received several names: it is the 'outer attic' of Politzer, the 'malleo-incus-squamoid space' of Kretschmann, the 'apical recess' of Merkel. When we speak of the attic we always mean this lateral portion. It is bounded above by the tegmen tympani and externally by a plate of bone from the squamoid which reaches down to the meatus (and separates it from the upper part of the tympanic cavity). The median wall is formed by the bodies of the malleus and incus, but the ossicles do not come in contact with the tegmen tympani above or the walls of the

^{*} Bd. i., S. 559 (Braunschweig, Vieweg und Sohn, 1885-1890).

tympanic cavity in front and behind. The gap thus left is filled up by a thin sheet of mucous membrane which is divided into a small anterior and a larger posterior portion by the ligamentum superius



FIG. 33.—THE ATTIC AFTER REMOVAL OF THE INCUS.

K, Attic; *A*, antrum; *M*, malleus; *Ch*, chorda tympani; *Tr*, tympanic membrane; *C*, internal carotid artery.

of the malleus, if this ligament is present (Fig. 34). The anterior portion of the layer of mucous membrane (*vF*) thus bridges over a space bounded by the ligamentum superius, the anterior surface

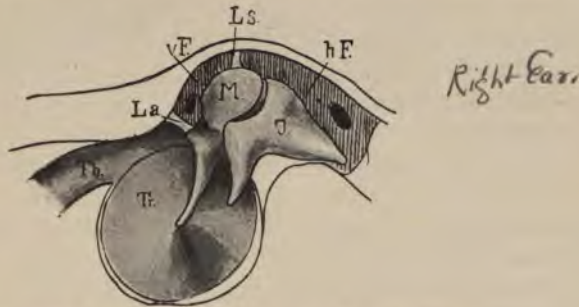


FIG. 34.—MEDIAN WALL OF THE ATTIC. (DIAGRAMMATIC.)

Tr, Tympanic membrane; *M*, malleus; *J*, incus; *La*, anterior ligament of the malleus; *Ls*, superior ligament of the malleus; *vF*, anterior sheet of mucous membrane; *hF*, posterior sheet of mucous membrane; *Tb*, Eustachian tube.

of the head of the malleus, the anterior ligament of the malleus and the upper part of the anterior wall of the tympanum. The posterior part (*hF*) covers a space bounded by the superior

ligament, the upper surface of the body of the incus and its short process, the entrance to the antrum (or the upper part of the posterior wall of the tympanum), and the tegmen tympani. Openings may be found both in the anterior and posterior divisions of this sheet of mucous membrane, allowing of communication between the attic and the remaining portions of the tympanic space. Below, the lateral and median walls come together forming a space the width of which depends on the curvature of the lateral wall and the position of the ossicles. This cleft is filled by a mass of ligament fibres which radiate from the neck of the malleus forwards, outwards and backwards to the tympanic margin of the squamoid, forming the axial ligament of Helmholtz. The fibres may be divided into three bundles—the ligamentum mallei anticum already mentioned, the ligamentum externum, and the ligamentum posticum.

The floor of the attic—or rather a portion of it, the external ligament of the malleus—forms the roof of another exceedingly small space named after its discoverer Prussak. This space is bounded on the side of the auditory canal by Shrapnell's membrane, internally by the neck of the malleus and below by the upper surface of the short process; anteriorly it ends in a *cul de sac*. Behind, Prussak's space communicates with the posterior recess of the drum (Tröltsch), a reduplication of the tympanic membrane on its inner surface in the lower margin of which the chorda tympani runs (Fig. 35).

In the formation of Prussak's space a variation may appear, in that the ligamentum externum is inserted, not into the margo tympanicus, but into Shrapnell's membrane itself. The lowest part of the lateral wall of the attic will then be formed by membrane instead of bone. In such a case pus in the attic may perforate directly into the meatus, but normally it must first pass through Prussak's space.

The existence of primary inflammations of the attic is denied by some (*e.g.* by Bezold), but they certainly occur. This view is shared also by Kümmel who has recently suggested a classification of cases of suppurative otitis media into mesotympanal, or those which arise in the main tympanic cavity, and epitympanal—*i.e.* those arising in the various parts of the recessus epitympanicus, the mastoid antrum or the mastoid cells. I see every year a few cases of primary inflammation of the attic. We should probably meet with a larger number of cases, only that the symptoms are very

slight. Deafness does not, as a rule, occur at all, or only in a very slight degree. The following is a typical case: A patient who had never suffered from any ear trouble noticed during an attack of cold in the head a sharp darting pain in the left ear, which, however, soon ceased and to which he paid no attention. Suddenly, a week later, he became very deaf in the ear, 'as if there was a wall in front of it.' He consulted me, thinking the meatus was stopped with wax. On examination I found purulent secretion covering the drum. Its lower part was dulled but otherwise normal; the vessels of the handle of the malleus were seen to be injected. The



FIG. 35.—ATTIC OPENED FROM ABOVE.

K, Attic; *Tr*, tympanic membrane; *M*, malleus; *Ch*, chorda tympani;
Str, lateral sinus.

pars flaccida (Shrapnell's membrane) was swollen and reddened, the short process invisible. At the upper pole, protruding through a perforation in Shrapnell's membrane, was a mass that was either a small granulation or a portion of mucous membrane much swollen. The hearing became normal as soon as the pus was removed and complete recovery followed in about three weeks. On examination subsequently a well-known picture was seen: Shrapnell's membrane was indrawn and a small light reflex on it showed the position of the cicatrized perforation.

Whether the attic is diseased primarily or secondarily in con-

junction with the rest of the tympanic cavity a suppurative inflammation must be always looked upon as serious.

The anatomical structure is, as we have seen, unfavourable to free drainage. If we examine in a dissection the thin, transparent folds of mucous membrane, it is difficult to understand how they can offer resistance to the pus and prevent its passage into the main tympanic cavity; but if we study a pathological specimen and see how the inflamed mucosa is swollen so as to fill up almost the whole space, the difficulty is at once explained away. The pus, therefore, breaks out at the lowest point and perforates Shrapnell's membrane. If from defective drainage or other causes the suppuration becomes chronic, carious disease of the bone will result; but in some cases, undoubtedly, it is the other way about and the caries is the cause for the continuation of the suppurative process.

It may therefore be laid down that in chronic suppuration a perforation of Shrapnell's membrane, with or without destruction of the margo-tympanicus, points definitely to disease of the attic and its contents.

Marginal perforations, especially those at the upper pole, are not only paths for the escape of pathological products from the corresponding middle-ear spaces, but often also serve as entrances for the ingrowth of epidermis which leads to the formation of the so-called cholesteatomata.

Cholesteatoma.—Opinions differ as to the etiology of this tumour, if tumour it may be called. All are agreed that true cholesteatoma, a heteroplastic new growth (Virchow) of congenital origin, must be distinguished from the formation which aurists call cholesteatoma (or better, following Körner, pseudo-cholesteatoma), a product of chronic suppuration in the middle ear. The different authorities are not yet in agreement as to the relative frequency with which the two kinds of growth occur. Körner* believes that true cholesteatoma is commoner than is generally supposed. It would take up too much space to discuss his reasons for this opinion, but I may state that I cannot agree with him. In my experience true cholesteatoma is very rare.

The cholesteatomata so often seen in suppurative otitis media (in our clinic out of 1,400 radical operations cholesteatoma was observed in 616 cases) are undoubtedly, as Bezold and Habermann first pointed out, due to an ingrowth of the meatal epidermis through a

* 'Eitrige Erkrankungen,' S. 119 *et seq.*

marginal perforation so as to cover the diseased mucous membrane. If the inflammatory process in the middle-ear spaces were completely at an end, this ingrowth of the epidermis would form a process of healing, and would finally result in a covering over with skin of the mucous membrane which had been ulcerated and deprived of its epithelium. But since the suppurative inflammation still exists at this stage in a milder degree (Leutert), the newly formed epidermis will continue to be cast off by the diseased tissues underneath. Being retained in the narrow enclosed spaces, these detached masses in their turn set up irritation and maintain the suppurative process. Owing to caries and the pressure of the epithelial masses the cavity constantly increases in size, until finally perforation occurs either outwards into the meatus or inwards into the interior of the skull.

Other modes of development of cholesteatomata have been described by Tröltsch, Lucae, Schwartz, Leutert, Zeroni, and others. These, however, are rarities and it would be profitless to discuss them fully here.

How is cholesteatoma to be diagnosed? In some cases this is easy, in others it is impossible to be quite certain. The surgeon's suspicions should be aroused if he finds in the washings from a case of middle-ear suppuration shreds and fragments of epidermis which sink in water. A peculiar evil smell of the discharge, similar to the odour of old cheese, is also suspicious.

The diagnosis of cholesteatoma may be said to be established beyond doubt if the following signs are present:

1. If, when the meatus has been washed out, shreds of epidermis are seen protruding from a marginal perforation above and behind or at the upper pole of the drum.
2. If similar masses can be removed from the attic with a blunt, bent probe, either immediately or in the course of a few days.
3. If the smell of the discharge does not improve in spite of suitable treatment.

Unfortunately, all cases are not so comparatively simple. The shedding of epidermis may be minimal, or it may be hindered or concealed by granulations. Again, the perforation in Shrapnell's membrane may be so small that no epithelial masses can be brought out through it, and these are the most dangerous cases of all. I have seen several patients admitted into the hospital with pronounced symptoms of purulent meningitis. On examination, the tympanic membrane was found to be intact, except for a small

perforation, scarcely as large as the head of a pin, at the upper pole. From the perforation exuded a very small amount of stinking discharge which had collected close to the drum at the deepest part of the meatus. This was all that could be seen during life, and yet in autopsies on two of the cases we found extensive cholesteatomata which had perforated in one into the middle and in the other into the posterior fossa of the skull.

It is thus impossible to decide from the external signs how much damage a cholesteatoma has done. **A safe rule to follow is that the radical operation is indicated if the diagnosis of cholesteatoma can be made with certainty, or even with strong probability.**

But there is no rule without an exception. Sometimes the new formation has found a way out for itself by breaking through the posterior wall of the meatus. The following picture is then presented: In the meatus lie softened, evil-smelling masses of epidermis which it may be impossible to remove completely at the first sitting. They may be also concealed from view at first by granulations which spring from the edges of the perforation in the posterior meatal wall. The granulations are scraped away and the meatus gradually cleared by syringing and by removing the cholesteatomatous masses. It will now be seen that the portion of the posterior meatal wall nearest the median line is absent, that the attic is wholly or partially exposed and that little or nothing remains of the drum or ossicles. It is possible to look from the auditory canal into the mastoid process, where a large cavity with smooth epithelium-covered walls is seen. This is more or less the appearance of the parts after a radical operation, so that Nature herself has indicated to us the proper line of treatment for this disease.

Under these conditions it is unnecessary to open the cavity from the outside as well, unless in exceptional cases when caries is present and resists treatment. It is true that lamellæ of epidermis will continue to form and to be cast off, but these can be easily removed from the meatus; it is sufficient if the patient comes once every six months for treatment. He runs no risk, for it is only in a closed space that the cholesteatoma will increase in size and hollow out the bone. Further, in some instances we find that the ingrowth of epithelium has not advanced very far, nor is the pus at any time fetid. Masses of epidermis may be removed at the first examination through a perforation in the typical situation, but the amount of

shed epithelium diminishes daily. If the perforation is favourably situated and sufficiently large, the attic must be washed out frequently through a Hartmann's cannula, and under this treatment the purulent discharge gradually disappears. Finally the ear becomes dry and there is no further shedding of epidermis. Hence in doubtful cases, if there are no specially urgent symptoms, palliative treatment may be tried for a time.

The question now arises whether a radical operation is indicated in cases of chronic suppurative otitis media when we have to deal with caries and necrosis only. In my opinion immediate operation is not justified on these appearances alone, unless further symptoms are present. The surgeon must first try to bring about a cure by conservative methods or minor surgical measures.

Polypi and granulations are removed with a snare (see p. 16), and thereby freer drainage is provided. Granulations which cannot be seized by the snare are destroyed by cauterization with chromic acid, silver nitrate or lactic acid. Broad masses of granulation tissue are caused to shrink by dropping in alcohol, either concentrated or mixed with equal parts of glycerine. Carious ossicles may be extracted (see p. 20). The ear is syringed out several times daily. For this purpose we have used in our clinic for many years weak formalin solution, as suggested by Lucae (3 to 4 drops to $\frac{1}{2}$ pint of boiled water). I have been well satisfied with the results obtained with this mixture; the evil odour of the discharge often disappears very rapidly. Others recommend ear-drops of hydrogen peroxide. The attic itself may be again washed out through the tympanic cannula.

By these and similar methods a great many cases of suppurative otitis media with marginal perforation may be cured without further operative measures. I see this frequently, and I examine almost daily cases showing marginal cicatrices and perforations which are the remains of middle-ear suppurations that have healed without operation.

I consider the radical operation indicated only when conservative treatment will not bring about the desired result. If I find that palliative measures do not cause improvement, and, above all, if the discharge retains its evil odour, I do not postpone the operation longer. General rules cannot be laid down as to the exact length of time during which conservative measures should be tried. The surgeon must treat each case on its merits, relying on his own judgment and experience.

We have thus seen that caries and necrosis of the bone, and to a certain extent the presence of cholesteatoma, are not by themselves absolute indications for the radical operation. The surgeon must, however, operate immediately if to these signs are added the symptoms of acute mastoiditis or of an intracranial complication.

Not infrequently an acute exacerbation occurs in the course of a chronic suppuration, and the resulting affection of the mastoid then runs its course with the same symptoms and signs as a primary inflammation. Periostitis, infiltration of the skin and finally subperiosteal abscess, develop. A sinking in of the posterior superior meatal wall may occur, but it is less often a symptom of acute periostitis than a sign of a threatened perforation into the auditory canal. If the perforation has already taken place, the surgeon finds on examination a fistular opening in the posterior wall of the meatus. These appearances have already been fully discussed in the section on the indications for operation in acute mastoiditis.

As far as the indications for operation are concerned, there is a difference on one point between primarily acute affections of the mastoid and these acute exacerbations. In the former we may try to bring about resolution of a periostitis by external treatment, but in the latter any such endeavour is altogether inadvisable. In some of the secondarily acute cases recovery admittedly takes place whether they are treated or not, as is shown by many case histories; but the chronic process does not heal on that account, and the danger of perforation into the interior of the skull increases with each attack of acute mastoiditis.

In treating of the operations for intracranial complications we shall discuss their symptoms, both general (of which the chief is fever) and local. I shall confine myself at present to stating that all the considerations mentioned above in favour of delaying operation are invalid if there is even a suspicion of threatening cerebral complication. I must, however, mention here some general symptoms often accompanying suppurative otitis media, but of which the value may be difficult to estimate.

The first and most important is **headache**. It is met with in every degree, from a slight sense of pressure in the ear to violent pain spreading from the affected side over the whole head, sometimes localized in the frontal, sometimes in the occipital region. In one case it is intermittent, in another continuous. Often it is the headache alone which leads the patient to consult a doctor. Examina-

tion will show whether it is caused by a retention of discharges. The most violent headaches have often been cured by removing a polypus or granulations which had prevented free drainage. These and similar measures are, however, not always sufficient, and I think that the radical operation should not be too long delayed if there is no improvement, supposing, of course, that the pain is due to the ear disease. This last point is often difficult to decide. The surgeon must be guided by the condition of the tympanum. If it is certain that there is no chronic bone disease and no cholesteatoma, an operation is useless. The question arises most often in treating hysterical women. Operation may relieve the headache for a time, but it returns, and the surgeon may be led to undertake more extensive operative measures directed against supposed intracranial complications. Such cases have been frequently observed (F. Voss).

A second general symptom sometimes appearing in chronic suppurative otitis media is **vertigo**. As in Ménière's disease, the patient, when feeling perfectly well, may suddenly fall; everything seems to spin round and he cannot fix his eyes on any one point. *John* More ~~usually~~, however, there is only a more or less sudden feeling of dizziness, forcing the patient to sit down or lean against the wall, and soon passing away. The attacks recur, but gradually decrease in severity. In some patients I have succeeded in producing the vertigo artificially; if the meatus was closed by pressing on the tragus the attack immediately occurred and was accompanied by well-marked nystagmus. This last symptom was often present in a mild degree for a considerable time after an attack of vertigo.

The cause of the vertigo is now known; it occurs when the labyrinth is opened at any point by the suppurative process. The site of election for the perforation is the convexity of the anterior limb of the horizontal semicircular canal. The lesion will almost always be found at this point on operation if there is a typical history of dizziness. It is not sufficient merely to ask the patient if he has suffered from vertigo; if the answer is in the affirmative, it is necessary to inquire carefully into the type of the attack. Many patients understand by 'vertigo' faintness, or a mere passing feeling of nausea. The best proof that there has really been a disturbance of equilibrium is furnished by the presence of nystagmus.

It is clear that the appearance of vertigo is always a serious symptom. The way to the labyrinth has been opened up, and the radical operation must be performed without delay.

Another important symptom is **facial paralysis**. The nerve is most often affected in its passage through the tympanum (Fig. 36), for the wall of the Fallopian canal may be very thin, and even incomplete. Conduction of the suppuration along the nerve to the brain, leading to fatal meningitis, has frequently been observed. In tuberculous middle-ear suppuration paralysis of the nerve often occurs early, even when there is but little danger of meningitis.

In these cases the answer to the question whether to operate or not depends altogether on the state of the lungs and the general condition of the patient.



FIG. 36.—COURSE OF THE FACIAL NERVE (F.).

B, Horizontal semicircular canal (opened); *P*, promontory; *N*, hollow for fenestra rotunda (above this is the fenestra ovalis, from which the stapes has been removed).

We have now to deal with the cases of suppurative otitis media in which the process affects only the mucous membrane. These have been called 'safe cases.' They are characterized by the central position of the perforation in the drum (Fig. 31)—that is to say, between it and the tympanic ring there remains on all sides a more or less narrow border of membrane. In such cases are found the well-known kidney-shaped perforations (Fig. 31, *b*, etc.), narrowed in the middle by the protrusion of the end of the handle of the malleus into the hole in the drum. All sizes are found, from the tiny perforation scarcely as large as a pin's head, to almost total absence of the drum, of which only a narrow edge remains (Fig. 31, *e*). The

mucous membrane of the tympanic cavity may be seen in any of the stages of inflammation. Sometimes it is dark red in colour, much swollen and puffed up; in other cases it is only moderately injected and shows but little alteration from the normal.

The secretion is muco-purulent, never unmixed pus. When syringed out it forms flakes in the water and does not dissolve, so that the water never takes on a uniform milky appearance. Further, the discharge has no evil smell, unless it has been allowed to stagnate in the meatus for a considerable time. A certain amount of foetor may then develop, especially in children, but it disappears after the first thorough syringing and does not return if the meatus is regularly cleansed.

This mucoid secretion is altogether a product of the diseased mucous membrane of the tympanic cavity, the Eustachian tube, or both. If it is primarily produced by the tube and if the suppuration is kept up from there, the perforation is situated, as a rule, in the anterior half of the drum. The ostium of the Eustachian tube is sometimes so freely exposed that it is possible to look into it and observe the discharge welling out after it has been swabbed away.

In all these cases there is no direct danger of intracranial complications. They can only supervene if the otitis enters on an acute phase. If this happens the surgeon has an acute otitis media to deal with and must treat the patient accordingly.

In general, only expectant treatment should be employed in chronic middle-ear suppurations of this type. The patient is directed to have the ear syringed out once a day, or oftener, with boric acid or formalin solution and to come for examination, at first every week, later once in every four or six weeks. Months, or even years, may pass before the secretion dries up. The patient should be warned of this possible long duration beforehand. He will not then become impatient, especially as it is possible to assure him that he is threatened with no dangerous complications.

I consider it a mistake to perform the radical operation in these cases of suppuration arising from the mucous membrane, especially if the secretion comes altogether or partly from the Eustachian tube. Little or nothing is to be gained by making a wide opening into the tympanic cavity through the mastoid. The Eustachian tube itself cannot be reached, and in spite of the most careful scraping shreds of diseased mucous membrane are bound to remain

behind here and there, especially in the neighbourhood of the stapes and on the wall of the Fallopian canal. The result is therefore that, in spite of the extensive operation, healing does not occur. Even when the operation wound in the sound bone has become lined with epithelium, the discharge continues to exude from the Eustachian tube and from the parts not covered with epidermis. Moreover, the secretion will not dry up more quickly than it would have done if the operation had been omitted; it will only cease when all the diseased mucous membrane has been replaced by healthy tissue.

Although the radical operation is mostly performed for chronic suppurative otitis media, it may be indicated in acute cases sooner or later after the opening of the antrum, if this has not brought about a cessation of the secretion and if symptoms of retention appear. Fever, general malaise, severe headache warn the surgeon that it may be necessary to expose the tympanic cavity freely. The drainage from the antrum and through the paracentesis opening is obviously insufficient; there is danger that pus may collect in the middle ear. The most serious complications to be feared under these circumstances are—(1) perforation through the anterior wall into the carotid canal; (2) burrowing of the pus along the walls of the Eustachian tube under the lateral muscles of the neck; and (3) infection of the jugular bulb, which may be separated only by a thin layer of bone from the tympanic mucous membrane, or may even be in contact with it if there are lacunæ in the floor of the cavity.

Further, there are certain types of suppurative otitis media which may be associated from the start with disease of the bone in all the middle-ear spaces. These occur in the course of some of the infectious diseases, principally scarlatina and tuberculosis. The extensive bone disease brought to light during the operation, taken in conjunction with the changes in the tympanum previously observed through the aural speculum, will suggest the advisability of freely exposing all the middle-ear spaces, even when the surgeon has hoped that opening up of the antrum would suffice. It may happen, indeed, that the indications for the radical operation only arise in the course of the after-treatment.

The radical operation may be necessary for malignant growths in the tympanum and in cases of hæmorrhage from the internal carotid resulting from erosion of this vessel in its course near the anterior

tympanic wall. This last calamity can, however, scarcely occur without a preceding middle-ear suppuration, usually of a tuberculous nature. I have seen hæmorrhage from the carotid occurring in one case of cholesteatoma* after the radical operation. The bleeding was stopped by tight packing, but this, in its turn, caused retention of pus in the wound and the patient died of septicæmia. Ligature of the common carotid artery has been suggested and carried out, but in spite of it compression of the vessel at the site of erosion cannot be dispensed with, since blood continually reaches the distal portion through the free anastomosis of the circle of Willis. The long-continued tight packing will cause (at least when pus is present) an unhealthy condition of the wound, and death is liable to result, as in the case I have mentioned, from sepsis. Malignant growths in the middle ear also are almost invariably accompanied by suppuration.

Finally, it may be necessary to open up a path through the mastoid if a foreign body has become firmly wedged in the tympanic cavity and cannot be extracted through the meatus. As a rule, however, it is sufficient to widen the auditory canal by removing layers of its posterior wall.

THE OPERATION.

(a) Zaufal's Method.

The method of operation which I shall describe here is that generally followed in Lucae's clinic. It corresponds in the main to the method suggested by Zaufal, differing from this only in matters of detail; above all, we do not use the bone forceps as much as he recommends.

I perform Stacke's operation in certain definite types of case to be described later.

The skin incision is the same as for a simple chiselling opening of the bone. If the patient comes for treatment suffering from an acute exacerbation of a chronic middle-ear suppuration with infiltration of the soft parts, a subperiosteal abscess, a fistula in the cortex or discoloration of the bone, he should be treated as for a mastoid complication of acute otitis media: the diseased bone in the mastoid is exposed and traced inwards to the antrum. The only alteration

* *Berliner Klinische Wochenschrift*, 1901, No. 23.

in the procedure is that the posterior meatal wall is not spared, but removed as the chiselling progresses.

If, on the other hand, there are no acute symptoms in the mastoid, if the skin covering it is not affected, care must be taken not to make the incision too long. It is only very rarely necessary to carry it beyond, or even as far as, the apex of the process, for this portion of the bone is relatively seldom diseased. The antrum and its immediate neighbourhood mostly form the focus of bone disease in the mastoid itself. The skin incision requires to be only sufficiently long to allow of a good view of the field of operation when the edges are pulled apart. Above all, the upper part of the mastoid, the mastoid fossa, must be freely exposed, for it is through here that the surgeon must work in towards the antrum.

The upper limit of the field of operation is, as before, the temporal ridge or its prolongation backwards (see p. 41); the posterior limit is an imaginary line perpendicular to the temporal ridge (Fig. 22). Since the posterior meatal wall is to be removed, the anterior limit described for the previous operation is not observed.

The posterior cutaneous wall of the meatus must be separated from the underlying bone before the chisel is used. This is best done with a little pad of gauze held in a forceps. With care the cutaneous part may be separated from the bone in its whole length without injury. Stacke suggests that it should be cut through close to the drum, but I have found that tearing through the posterior cutaneous wall at its inner end causes no ill-effects, and I have therefore abandoned the use of a cutting instrument.

When it has been separated, the tube of skin is not removed from its bony canal, but a blunt hook is inserted which presses the posterior wall forwards until it touches the anterior wall. By this means a sufficiently clear view can be obtained down as far as the drum, and the rest of the cutaneous lining of the auditory canal, especially that on the anterior wall, escapes injury. This is very important for the subsequent process of epidermization, which must start from the meatal skin. I have had no experience of the necrosis which some surgeons have described as a result of the bone being laid bare.

The chisel is first applied close behind the suprameatal spine, and the lateral portion of the posterior wall of the meatus is removed in flat shavings. Alternating with these strokes, others are directed against the posterior part of the superior meatal wall, in order to enlarge the opening upwards. The meatus is thus gradually made

to undergo a funnel-shaped enlargement backwards and upwards. The opening must not extend too far in the upward direction; it may reach as high as the temporal ridge, but will not pass as a rule much beyond the superior meatal wall. On no account, however, must it be kept below this level; if it is, the antrum, which is sometimes very small, may be altogether missed. During this part of the operation the surgeon must always bear in mind that the roof of the antrum lies above the level of the meatus.

In many cases chiselling the bone is a matter of some difficulty; the bone is sclerotic and ivory-like and shows only here and there a bleeding-point. Very sharp chisels are necessary if any progress is to be made. I do not believe that this osteosclerosis is always a result of the chronic suppurative otitis media; in my opinion it is often one of the factors which determine the chronicity of the disease. In the acute stage it does not allow the suppurative process to spread beyond the antrum and its immediate neighbourhood: a firm wall of bone, resistant to destruction, opposes itself between the focus of suppuration and the periosteum. While in spongy mastoids cell after cell becomes infected and their parietes broken down, until finally the cortex of the bone is perforated, the inflammation may completely fail to reach the surface if sclerosis is present. Under these circumstances the passage is blocked but the suppuration continues deep in the bone. By degrees the micro-organisms diminish in virulence and a chronic condition ensues. It must, however, be understood that many other causes may assist in producing this result.

If the suppurative process finds softer and more spongy bone favourable to its progress in the other direction, towards the interior of the skull, it may, while still in the acute stage, reach the dura and set up an unexpected meningitis. From this we see that osteosclerosis in middle-ear disease is not, as was formerly supposed, a protection, but a danger.

A mastoid may be sclerotic even though there is, and has been, no suppurative otitis media. This fact has been impressed on me by the examination of many dried specimens, and above all by the experience gained in my operation demonstrations in which hundreds of fresh temporal bones were dealt with. Not uncommonly a compact ivory-like structure of the bone is found, together with a normal tympanic cavity and normal drum. I do not, however, for a moment wish to dispute the statement that in many cases

the chronic middle-ear suppuration may favour the development of new bone and change a spongy mastoid into a sclerotic one.

If the wound is deepened in the manner described above, it will not be difficult, whether through a compact or a healthy mastoid, to find the antrum if it is large or has been increased in size by the disease. At about the level of the upper wall of the meatus a small cushion of granulation tissue is seen, beside which sometimes a little pus oozes out. Pus, however, may not be present—at least in visible quantity, since it can find its way out through a more or less large perforation in the drum. In chronic cases it does not generally well out in such large amount or under pressure as in acute suppuration. If it does the surgeon must recognize that he has to deal with an acute exacerbation or with retention from blocking of the drainage opening, perhaps by a polypus.

The operator should next determine the extent of the lateral wall of the antrum by inserting a blunt soft metal probe, bent at a right angle. This wall of the antrum is now removed, as well as the overhanging part of the roof, until the whole interior of the cavity is freely exposed to view. Granulations are removed with a wad of gauze or the sharp spoon, and the carious bone on the walls scraped away. During the swabbing out of the antrum it is generally possible to see at the juncture of the floor with the median wall a small circumscribed portion of the bone, which is distinguished by its colour from the red bleeding bone around. This yellowish-white, ivory-like, non-bleeding elevation is the ridge of the horizontal semicircular canal. It is always well to remove sufficient bone to see it clearly; it can then scarcely be injured. If the antrum is fairly large, the ridge will be easily found; but it may be exceedingly difficult to identify it if the bone is absolutely sclerotic and the antrum is small. The ridge will then scarcely differ in appearance from the rest of the bone, and other methods must be tried to determine its position.

The convexity of the horizontal semicircular canal forms the threshold of the aditus, the entrance to the antrum from the attic. Some authors apply the term 'aditus' to the attic itself, but I do not consider this correct, since the attic is really a part of the tympanic cavity. The word should be used to denote only the open door between the attic and antrum.

If the antrum is fairly large, and has been properly opened up, the communication between it and the tympanic cavity can be easily

seen. Above and in front of the ridge of the semicircular canal granulations or masses of cholesteatoma are seen, and these form a sausage-shaped mass protruding into the antrum when pressure is exerted on the tympanic membrane through the meatus. If the antrum is small the aditus is not so easily recognized. The bone should be sounded with a blunt probe, bent at a right angle, at the spot where the opening ought to be. If the end of the instrument slips in forwards and outwards, and is caught so that it cannot be

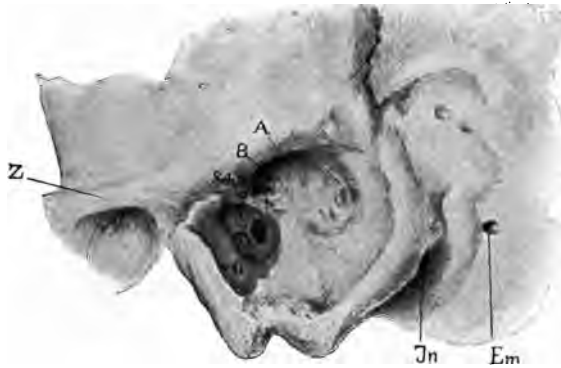


FIG. 37.—THE RADICAL OPERATION.

Z, Zygomatic process; *vG*, anterior wall of the meatus; *Tr*, tympanic membrane, showing perforation; *Sch*, short limb of the incus; *B*, ridge of the horizontal semicircular canal; *A*, mastoid antrum; *Jn*, digastric fossa; *Em*, mastoid emissary vein. The posterior wall of the meatus has been completely removed, except for a small piece of the median end shown in the plate lying between the two dotted lines. To remove this bridge the chisel is applied at its upper end.

drawn straight out parallel to the meatal canal, it is certainly in the aditus.

Let us consider for a moment the picture now presented by the operation wound (Fig. 37). Owing to the removal of the outer two-thirds of the posterior meatal wall, the meatus and the hollow made in the mastoid form a single cavity, the deepest points of which are posteriorly in the antrum and anteriorly in the tympanum. Between these two hollows is a bony crest, the median third of the posterior wall of the meatus, still connected with the lateral wall of the attic. The dividing crest is interrupted only by the opening of the aditus; the perforation is sometimes visible and can always be found with the

probe. The bridge of bone must be now removed, so as to leave a broad communication between the antrum and the tympanic cavity and make the latter accessible from behind.

In simple opening of the mastoid and in the part of this operation already described, it was only necessary to beware of injuring the dura or sinus (see p. 45 *et seq.*), but at this point two new dangers present themselves—namely, opening of the horizontal semicircular canal and injury to the facial nerve. The situation of the semicircular canal has already been considered, and if it has been well cleared it will not be damaged by a careful worker. If, however, it is not visible, it is necessary to guard against injuring it by other methods which we shall discuss presently.

The facial nerve runs horizontally in the Fallopian aqueduct on the median wall of the tympanum, immediately below the roof and above the fenestra ovalis (Figs. 36 and 40). At the posterior margin of the fenestra it lies under the horizontal semicircular canal, and the bone surrounding the nerve helps to form the threshold of the antrum. From this point it passes on to the posterior wall of the tympanic cavity, turns downwards, passes below the level of the floor of the meatus and runs perpendicularly down to the stylo-mastoid foramen.

Schwartz* speaks of this as the 'steep course' of the facial. He says that there are variations from the perpendicular course, and that the nerve after its change of direction may approach the horizontal plane to a greater or less degree ('horizontal' or 'oblique' course). It may thus come to lie considerably further from the median line of the body than usual and is then in danger of being injured during the removal of the posterior wall of the meatus. Randall,† on the contrary, asserts that the direction taken by the nerve is almost always vertically downwards. According to Schwartz, the distance between the nerve and the surface of the posterior meatal wall is variable: it may lie close to the surface or may lie 1 centimetre away from it.

Even though a lesion of the facial nerve is not an immediate danger, the remaining third of the posterior meatal wall should be carefully removed piecemeal, until nothing but a narrow bridge remains. This is best done from above downwards by gentle taps with a flat chisel. In rare cases the end of the short process of the incus,

* *Archiv für Ohrenheilkunde*, Bd. lviii., S. 26.

† *Zeitschrift für Ohrenheilkunde* Bd. xlv., S. 286.

which is attached underneath the horizontal semicircular canal, is seen (Fig. 37). As a rule, however, it is covered by granulations or the incus is totally or partially destroyed by caries.

The last remaining piece of the posterior superior meatal wall may be cut through with a small narrow-bladed bone forceps, as Körner recommends. This is easy if the antrum is moderately roomy and the bone is not too hard. In sclerosed mastoids, however, in which the antrum is often exceedingly small and the bone as hard as ivory, the use of a forceps is difficult and dangerous. In one of my cases the bone was so hard that a blade of the slender forceps broke. On the other hand, the forceps may slip and injure the very structures, particularly the Fallopian canal, which the operator is endeavouring to avoid. I therefore no longer use this instrument, but remove the bridge of bone with the hammer and chisel. The chisel is applied at the upper end of the bridge close beneath the tegmen tympani, and the bridge is fractured with a single blow of the hammer. The chips of bone are removed with a forceps, leaving a free opening between the antrum and the tympanic cavity.

If the operator does not take the precaution of removing the bridge from above downwards, but uses the chisel from below, working at the level of the floor of the meatus, it may easily happen that the horizontal semicircular canal is struck and the membranous lining opened. The first sign that this accident has happened is the appearance of a small bleeding spot on the convexity of the ridge. When the blood is swabbed away, the canal is seen as a narrow groove running from before backwards, averaging 1 to 2 millimetres in length according to the amount of bone which has been broken off.

Traumatic opening of the horizontal semicircular canal, which probably every aurist has to confess to at least once in the early years of his practice, is in itself not dangerous if the wound remains aseptic—I have never seen serious results from it—but if the wound becomes infected, a labyrinth suppuration leading to fatal meningitis is a possible sequela.

The consequences of opening the semicircular canal are in any event very unpleasant for the patient. The first symptom is severe dizziness on sitting up in bed, and this makes itself felt soon after he has recovered from the effects of the anæsthetic. He cannot fix his gaze on any object; everything seems to sway and turn before

his eyes. If he nevertheless remains in the erect position, nausea and vomiting soon set in. These symptoms are accompanied almost invariably by horizontal nystagmus. The movements of the eyes continue, no matter what position the patient is in, and are most marked when he looks towards the sound side. Only when lying down he feels comparatively well; in severe cases every change of position brings out the symptoms just described. Rest in bed is absolutely necessary. The vomiting ceases first, the dizziness then becomes gradually less and in a week or a fortnight, on an average, no symptoms of the labyrinth lesion remain beyond a slight nystagmus. Vertigo and even vomiting may, however, be started while the wound is being dressed by incautious touching of the injured semicircular canal, or by packing the cavity too tightly with gauze.

As a rule, the removal of the remains of the posterior superior meatal wall is not sufficient to expose all parts of the tympanic cavity. The lateral boundary of the attic must also be cut away, until the roof of the meatus and the roof of the tympanum and antrum lie in one plane. Further, a piece of the posterior wall of the meatus, 'Stacke's spur,' still remains in position. It is absolutely necessary to remove this in order to get a clear view into the posterior inferior part of the tympanum, but when removing the spur the surgeon must be particularly careful to avoid injuring the facial nerve (Fig. 40). The anaesthetist must remove the inhaler from the patient's face and watch for twitching in the region supplied by the nerve. The spur is cautiously levelled down with a fine, narrow chisel; only a very thin layer should be removed at each stroke. If the face twitches, showing that the nerve has been irritated, the chiselling must be stopped. As a rule, it is not necessary to go so far; the posterior inferior meatal wall will have been previously levelled down to the floor of the operation cavity and a sufficiently clear view of the posterior inferior part of the tympanum obtained. It would be wrong to continue the removal of the bone in every case until the face commenced to twitch. Warning is often given of the proximity of the nerve by a sudden hæmorrhage coming from a divided twig of the stylo-mastoid artery. This bleeding is sometimes quite unpleasantly free and only to be stopped by packing the cavity for some little time.

Many operators use an electric burr for the purpose of levelling down the spur and other inequalities in the field of operation. I

have not tried the burr on the living subject, but doubtless it is a safe instrument when used by a practised hand. In trying it on the cadaver, however, I noticed several disadvantages—for instance, a tendency to slip off the projection which is to be removed. I therefore do not use it in my operations, as I consider the chisel a speedier and safer instrument.

When the tympanic cavity has been freely opened up in all parts, it must be cleared out. The ossicles, or what remains of them, are generally removed as soon as they are exposed by chiselling away



FIG. 38.—THE RADICAL OPERATION—continued.

Tr, Tympanic membrane; *B*, ridge of horizontal semicircular canal; *A*, antrum; *G*, meatus; *M*, malleus; *J*, incus; *S*, stapes. The remainder of the posterior wall of the meatus and the lateral wall of the attic have been removed; the ossicles are seen *in situ*.

the last remaining portion of the posterior meatal wall (Fig. 38). The malleus may be left *in situ* in rare cases when it is certainly healthy and the caries is confined to the incus and the posterior part of the attic. I have only once allowed both ossicles to remain—in a case of cholesteatoma where the disease was, as it were, in a closed sac in the mastoid (cholesteatoma verum?), whereas the attic had healed up. The removal of the ossicles is very simple. The incus is first seized with a fine bayonet-shaped forceps (Fig. 5) and levered out carefully. It breaks away easily from its attachments to the malleus and stapes; there is no reason to fear a dislocation of

the latter. The malleus is then seized by its neck and removed in the same way. If the anterior part of the drum is still *in situ*, its attachment should be spared as much as possible and the malleus freed from it. I make use of this portion of the membrane by applying it to the anterior inferior wall of the tympanic cavity, in order to bring about more rapid closure of the ostium of the Eustachian tube. I can strongly recommend this manœuvre. The cavity becomes more quickly lined with epidermis and the open condition of the Eustachian tube, which is unpleasant and delays



FIG. 39.—THE RADICAL OPERATION—*completed*.

A, Antrum; *B*, ridge of horizontal semicircular canal; *S*, stapes; *F*, aqueductus Fallopii; *P*, promontory; *N*, hollow for fenestra rotunda; *R*, recessus hypotympanicus (cellar). The ossicles and the drum have been removed; Stacke's spur has been levelled down.

healing, is avoided. Unfortunately, it is only possible to employ this method in a small number of cases, as the drum is generally either completely destroyed or reduced to a mere fragment.

If the floor of the tympanic cavity is below the level of the floor of the meatus—that is, if we have to deal with a deep 'cellar' space (Fig. 39)—the bone forming the floor of the meatus must be bevelled towards the tympanum. Otherwise a collection of pus or a mass of granulations may form in the course of the after-treatment and delay healing.

The final step in the operation on the bone is to clear out the

pathological contents of the tympanic cavity (granulations, masses of cholesteatoma), and to scrape away the carious bone from its walls. Soft granulations and blood are best and most safely removed with gauze swabs. The sharp spoon should not be employed until the cavity has been cleared to some extent and a good view of its interior obtained.

from

I use for choice a small double curette, and apply only gentle pressure in scraping. If possible, no scraping at all should be done at the posterior and upper part of the cavity, as the stapes is in that region and is usually concealed from view by a mass of granulations. The ossicle may be dislocated by the instrument, and this accident is liable to set up meningitis, as I had occasion to observe in one of

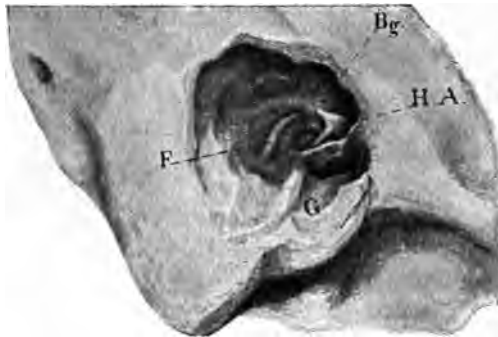


FIG. 40.—COURSE OF THE FACIAL NERVE.

F, Facial nerve; *Bg*, horizontal semicircular canal; *HA*, malleus and incus; *G*, meatus.

my cases. If a large pad of granulations lies in the region of the fenestra ovalis, the surgeon may try to remove it under good illumination; but if he cannot do so easily, the attempt should be abandoned. The granulations will disappear of their own accord during the course of the after-treatment.

Above the fenestra ovalis and further forwards lies the aqueductus Fallopii, the walls of which are sometimes very thin and may even be interrupted by lacunæ. Here, too, a certain amount of caution is necessary to avoid crushing the nerve. If the facial nerve is already exposed for a portion of its length by the carious process, it is seen as a yellowish-red cord running in the direction already described. In such cases the surgeon is often surprised after the

operation by the sudden onset of facial paralysis: the patient cannot close his eye properly, the naso-labial fold is obliterated, he cannot whistle, and so forth. These symptoms are, as a rule, the results of mechanical, rarely of inflammatory, irritation of the nerve. They disappear spontaneously sooner or later. Still, when the nerve lies exposed it is necessary to avoid tight packing, lest permanent damage should follow. I remember one case in which, in the region of the vertical course of the facial on the posterior tympanic wall, there were bleeding granulations defying all treatment. I endeavoured more than once to press them apart with a tampon, but each time slight paresis set in, which disappeared when the packing was removed. After a considerable time a sequestrum separated which proved to be a piece of the wall of the aqueductus Fallopii, and thenceforward the epidermization of this region progressed rapidly.

If the nerve is partially or completely divided during the operation, complete facial paralysis is generally the result. Still, there are some cases on record in which it regained its function after some years. We must suppose that the two ends lying in the bony canal as in a splint must have reunited. In recent times the distal end of the facial has been successfully grafted on to the spinal accessory (Gluck*) and to the hypoglossal (Körtel†), and its functional activity restored.

When the curette is being used in the neighbourhood of the ostium of the Eustachian tube, the proximity of the internal carotid must be remembered. This vessel runs close to the anterior wall of the tympanum and is often separated from the cavity only by a very thin layer of bone. It is always possible to injure the artery or the venous plexus surrounding it by a too energetic manipulation of the instrument. On the other hand, this region must be scraped thoroughly, as it may otherwise be the cause of imperfect healing.

The bulb of the jugular lies under the floor of the tympanum, and the bone covering it may be extremely thin—in fact, several cases are mentioned in the literature in which the bulb partially projected into the cavity, being covered only by mucous membrane. This is, of course, a very rare occurrence; but, nevertheless, it is well to use the sharp spoon with gentleness at this point.

* *Deutsche Medizinische Wochenschrift*, 1903; 'Sitzungsbericht der Berliner Otologischen Gesellschaft vom 10 März, 1903.'

† *Loc. cit.*, 1903, No. 17

facial
nerve

In scraping the tegmen there is less danger. If it is thin and fractures at one point, every fragment of bone must be removed with care (see pp. 47 and 48). Exposure of the dura is *per se* not dangerous.

Thus every granulation is removed as completely as possible, and every piece of carious bone scraped away, until the walls of the tympanum of the antrum and the rest of the operation cavity are quite smooth and show no irregularities.)

Up to the present we have only considered the appearances in caries; we must now discuss the conditions found when cholesteatoma is present.

In the 'cold cases'—that is, where the indication for operation has not been given by an acute exacerbation—the matrix of the cholesteatoma is reached more or less deep in the sclerotic bone. Underneath the matrix the layers of epidermis appear, glistening like mother-of-pearl. In isolated cases it is possible to expose the whole outer surface of the tumour and to shell the structure almost *in toto* out of its cavity. The walls of the hollow show recesses here and there, but are for the most part smooth. On careful inspection, extensions of the growth may be seen which have bored their way into the bone. It is very necessary to remove all overhanging ledges of bone in order to be able to examine every recess of the cavity. Every trace of the cholesteatoma must be next scraped away, and every projection of it is followed up with hammer and chisel. If this is not done a recurrence in the form of a small pearl-shaped tumour, gradually increasing in size, will be observed either in the course of the after-treatment or perhaps when the whole cavity has become lined with epithelium. These projections of the tumour substance into the bone are most easily overlooked in the posterior part of the cavity, especially if the sinus projects far forwards. The operator must not be satisfied until he has made this recess visible and accessible to his instruments. Even a partial exposure of the sinus is, I think, permissible in these cases, although I consider that exposure of the sinus is always attended with a certain amount of danger. It will, however, very rarely be necessary. In order to see into this posterior bay of the cavity it is usually sufficient to turn the head towards the diseased side after the overhanging bone has been removed as far back as the sulcus.

It has been recommended to leave the matrix of the cholesteatoma behind, on the supposition that it may become converted into a

healthy epithelial lining. I tried this, but gave it up again, because the lamellæ of epidermis continued to form and recurrences took place from the extensions of the cholesteatoma in the bone.

The picture is quite different when the cholesteatoma has become decomposed. The cause is generally the onset of an acute exacerbation of the chronic suppuration. The signs of acute inflammation may often be observed on the surface of the mastoid. Its cortex may be perforated by a fistula. From the opening exudes a purulent secretion, differing from the pus of an ordinary acute mastoiditis by its abominable, sometimes absolutely putrid, odour. It has sometimes an ichorous character, is thin and of a brownish colour. The chisel opens a cavity filled with a grey, greasy, stinking mass. The matrix is softened and disintegrated; soft granulations are attached to the walls of the cavity. At some points the bone may be carious and may have pads of granulation tissue embedded more or less deeply in its substance.

If the cholesteatoma is large, the sinus and the dura of the posterior and middle fossæ are not infrequently found exposed. Even when no signs of intracranial complications are present, particular care must be taken in watching the further course of the disease. I have seen the symptoms of cerebral abscess develop gradually in cases of this kind.

When a large cholesteatoma is present, the posterior wall of the meatus is almost always thin, or even partially destroyed, in its median half. The growth has found a way out, and Nature has partially performed a radical operation. Often nothing remains to be done but to level down the spur and to remove the lateral wall of the attic.

Cholesteatoma may spread in the meatus itself, eroding and breaking down the walls, especially the anterior and inferior. An abscess of the soft parts situated deeply under the muscles of the neck is the result. As a rule healing may be brought about by enlarging the fistula in the bone, thus opening up the abscess from the meatus. In some cases of this kind, however, I found it necessary to make a counter-opening for drainage in the side of the neck.

Even the hard bony capsule of the labyrinth cannot successfully resist the destructive effects of long-continued pressure by a cholesteatoma; perforation of the horizontal semicircular canal, ushered in by the symptoms already described (p. 77), is not uncommon.

It is to be noted that this lesion very rarely occurs in cases of caries alone. The perforation is characterized by its dark grey or black colour ; it may be exceedingly small—half as large as the head of a pin—or some millimetres in extent. It can be distinguished from a traumatic lesion by its colour (the latter always appears reddish), and, above all, by the fact that the surrounding bone does not bleed. By repeated swabbing the granulations which cause the dark colour may be removed and the groove of the canal brought into view. These manipulations may also enlarge the perforation, the thin bone surrounding it being pressed in and the membranous canal further exposed.

I therefore avoid as much as possible touching this spot with swabs, and I do not remove the granulations by scraping or chiselling away the surrounding bone. I do not agree with Jansen, Körner and others, who consider that the fistula may be enlarged without danger. In my opinion the granulations form a protecting wall, the removal of which may open for the infection a path into the labyrinth. If all the diseased tissues in the mastoid and in the tympanic cavity have been removed, there is no reason to fear a further advance of the purulent inflammation from these regions, and the small labyrinth perforation will heal of itself. Intracranial complications very rarely arise from an isolated carious lesion of the horizontal semicircular canal. I have only seen two such cases, in which an infective process in the semicircular canals set up in one instance meningitis, in the other a cerebellar abscess. In all other cases healing took place without complications, and I am convinced that if I had employed more active measures more harm than good would have been done. If, however, clear symptoms of labyrinth suppuration are present, it must be opened up, as we shall see later on.

Before passing on to the second, or plastic, part of the operation, I will describe briefly the other (Stacke's) method of opening up the middle-ear spaces. I sometimes follow this method, but in a somewhat modified form.

(b) Stacke's Method.

Stacke* makes a curved incision in the line of attachment of the auricle, beginning above the temporal ridge and reaching as far as

* 'Die operative Freilegung der Mittelohrräume,' etc. (Franz Pietzcker, Tübingen, 1897).

the temporal fascia. At right angles to the first incision, a second, dividing only the fascia and periosteum, is made forwards under the skin, which is drawn aside for the purpose. When the periosteum has been pushed back off the mastoid, the posterior and upper part of the cutaneous meatus is levered away from the bone and is cut through with a narrow scalpel with a curved edge (Fig. 41).

The cutaneous meatus is raised out of the bony canal with a slightly bent raspatory (Fig. 42). It is either completely lifted out or is left partially attached to the bony wall, and is then held forwards with a blunt hook or a thread passed through it. The

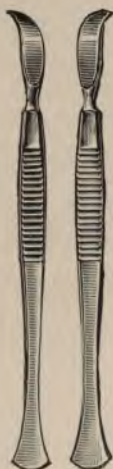


FIG. 41.
CURVED SCALPEL.



FIG. 42.
RASPATORY.



FIG. 43.
CURVED CHISEL.



FIG. 44.
STACKE'S PROTECTOR.

region of the drum is now well seen. The malleus, if possible, should be extracted, and the lateral wall of the attic is then removed with a curved chisel, the blade of which is slightly bent forwards (Fig. 43). In order to avoid injuring the facial nerve, the semi-circular canal and other important structures, Stacke suggested the use of a protector (Fig. 44), which is inserted and held by an assistant under the piece of bone to be cut through with the chisel. When the lateral attic wall has been so far removed that the superior wall of the meatus is continuous with the roof of the attic, the incus, if still *in situ*, must be extracted. The protector is then inserted into the aditus, and the antrum is opened by removing the

median portion of the posterior meatal wall. The remainder of this posterior wall and the cortex of the mastoid process are then chiselled away until the antrum forms a broad trough, and finally the spur is levelled down.

Stacke's operation has the advantage that the antrum cannot be missed even when it is very small ; it is necessarily reached through the aditus by working from the tympanic cavity. On the other hand, the operation is rendered more difficult by the narrowness of the field when the surgeon is engaged on the median end of the meatus, and the hæmorrhage is more disturbing than in the operation suggested by Zaufal. I therefore only follow Stacke's method when forced to do so by particular anatomical conditions becoming manifest during the operation, especially when complete osteosclerosis is present and the antrum is so small that it may be missed if sought by the ordinary route. If in the course of the usual operation I find myself at the depth, and in the position where the antrum should be, but cannot find the cavity, I remove first the lateral attic wall, extract the remains of the ossicles and seek for the aditus with a bent probe. From there the antrum can be easily opened up by Stacke's method.

Further, it is impossible to reach the antrum by the direct route through the mastoid process if the lateral sinus is situated far forwards. I have seen cases in which the first blows of the chisel exposed the sinus lying close to the posterior wall of the meatus (Fig. 27). The antrum was thus not in front, but to the median side of the vessel, and partially covered by it. I was thus forced to operate altogether by Stacke's method, or to look for the antrum, leaving the lateral portion of the posterior meatal wall at first untouched. I worked in towards the middle line away from the sinus and through the posterior wall of the meatus until the antrum was reached. This was a very wearisome task, and I think Stacke's operation would be better under these conditions.

translating
(bar)

CHAPTER IV

THE RADICAL OPERATION (*Continued*)

THE PLASTIC OPERATION: (a) Stacke's method; (b) Körner's method—After-treatment of the radical operation—Plastic operations for the closure of persistent retro-auricular openings.

THE PLASTIC OPERATION.

(a) Stacke's Method.

WHEN the radical operation has been completed (Fig. 39), the lateral portion of the auditory canal is still divided from the wound cavity by the cutaneous wall of the meatus, which was drawn forwards during the operation. Thus there are two passages leading into the antrum and the tympanic cavity—the artificial opening through the mastoid, and the meatus itself. Stacke was the first surgeon who got rid of the dividing wall and made the whole cavity into one by forming a flap from the posterior wall of the meatus. By laying this flap into the cavity in the mastoid he succeeded in covering its floor with skin, and thus facilitated the growth of epidermis over its walls. I still use Stacke's plastic operation, but with a modification introduced by Jansen.

When the tympanic cavity and the rest of the wound have been packed with gauze to prevent blood from collecting and stagnating therein, the clip forceps are removed from the anterior edge of the wound, and the auricle is once more cleansed with alcohol and sublimate solution. One hand (for the left ear the left hand, and *vice versa*) holds the auricle and turns it forwards, while with the other hand a narrow scalpel is pushed from behind through the soft parts at the level of the superior wall of the meatus, until the point appears in the entrance of the meatus at the junction of the posterior and superior walls (Figs. 45, 46). The point at which the knife is inserted lies close behind the anterior lip of the wound. The auricle must be turned a little backwards while the blade is being pushed

through from behind, in order that the surgeon may make sure that it emerges at the proper spot. Care must also be taken not to wound the anterior meatal wall, an accident which may easily happen if the knife is sharp, or if a little too much force is used.

When the point is seen to appear at the spot indicated, the knife is carried vertically downwards—that is, towards the apex of the mastoid, and in a direction perpendicular to the long axis of the

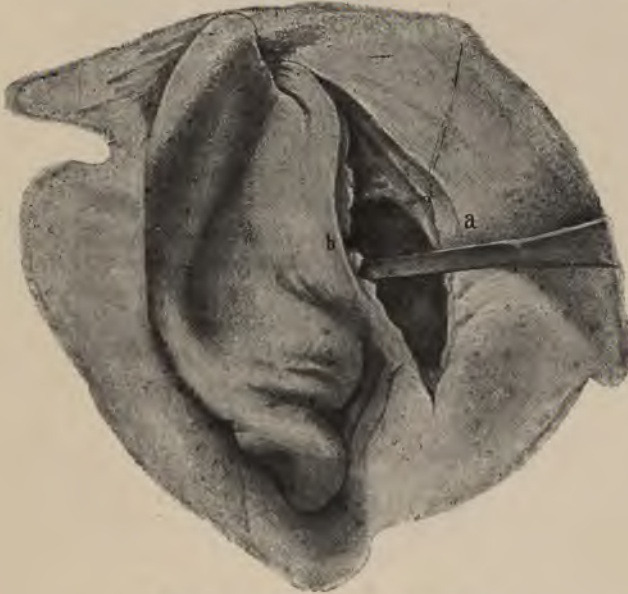


FIG. 45.—THE PLASTIC OPERATION.

a, Posterior, *b*, anterior, lip of the retro-auricular wound. The knife is inserted from behind, pointing towards the junction of the posterior and superior meatal walls.

auditory canal. In doing this the posterior part of the meatus itself and the soft parts behind it are cut through. The point of the knife must divide the skin of the meatus in the line where it passes on to the auricle. If the incision is lateral to this line, it will divide the cartilage of the ear; if it is to the median side, the outer end of the meatus will remain attached to the auricle and the opening into the operation cavity will be too narrow. The proper line can be easily found as follows: When the auricle is drawn away from the

head, the junction of the auricular cartilage and the meatus may be seen as a shallow groove (or a narrow shadow, according to the conditions of illumination), arching from above downwards, and it is in this line that the scalpel must travel. It sometimes happens that a beginner devotes all his attention to watching the point of the knife, and allows the base of the blade to travel too far in a lateral direction, cutting into the skin behind the ear. The result is a triangular tag of skin with a narrow base below, and bounded behind by the



FIG. 46.—THE PLASTIC OPERATION—*continued*.

a, Posterior, *b*, anterior, lip of retro-auricular wound; *c*, lateral margin of the vertical incision, the direction of which is shown by the dotted line. The knife has been pushed into the meatus.

anterior lip of the original wound. The path of the knife must therefore be watched from both the back and the front, the auricle being drawn forwards or backwards as required.

Before this perpendicular sagittal incision is made through the meatus there is usually rather free hæmorrhage from a branch of the posterior auricular artery. With a little practice it is easy to pick up the spouting vessel at the lower angle of the wound; if this does not succeed, it must be sought for, the margins of the wound being held apart. It is not necessary to tie the artery if the clip forceps

is left on until the end of the operation and removed only when the dressings are to be applied.

The second incision for the formation of the flap runs horizontally at the junction of the posterior and superior walls of the meatus, and splits the canal in its long axis. To make it a small retractor is inserted into the slit in the posterior meatal wall and pulled for-

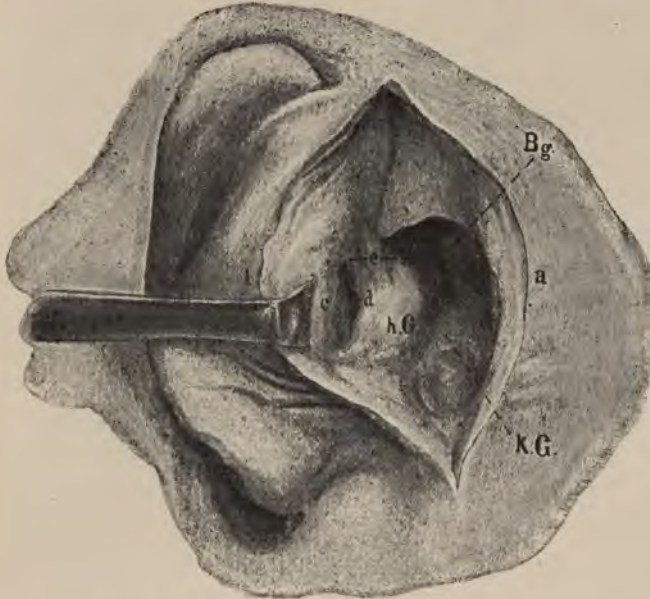


FIG. 47.—THE PLASTIC OPERATION—*continued*.

a, Posterior, *b*, anterior, lip of retro-auricular wound; *c*, lateral margin of the vertical incision; the interrupted line passing through *e* shows the direction of the horizontal incision; *hG*, posterior cutaneous wall, and *kG*, remains of posterior bony wall, of the meatus; *Bg*, horizontal semicircular canal. The vertical incision is held open with a retractor.

wards, in order to bring the lumen of the canal into view (Fig. 47). The wall of the meatus is then grasped from behind with a toothed forceps, and the soft parts are pulled backwards and outwards until the lumen gapes sufficiently. All gauze packing is now removed from the wound, and a straight scissors inserted through the vertical incision in such a manner that one blade lies in the meatus and the other outside. The scissors is brought as high up as possible, to

the junction of the posterior and superior meatal walls, and is pushed inwards until the point of the blade lying inside the canal comes into view deep in the wound. A single cut is then made with the scissors in the desired direction (see the dotted line in Fig. 47), and the formation of the flap is complete. The flap is large in proportion as the meatus is long, and as the longitudinal incision is placed high up towards the superior meatal wall. It is therefore

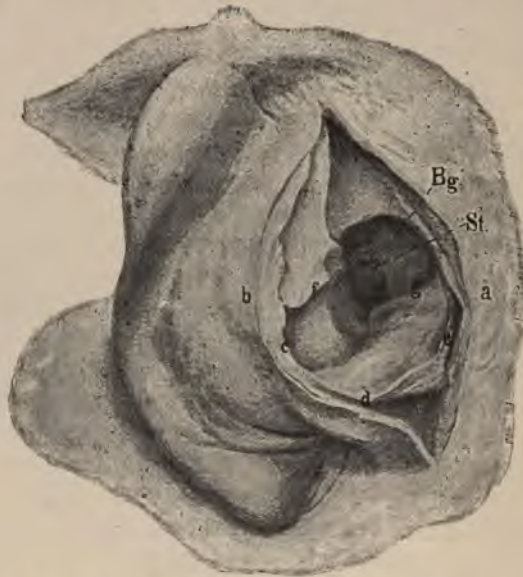


FIG. 48.—THE PLASTIC OPERATION—*continued*.

a, b, Lips of retro-auricular wound; *c*, lateral, and *d*, median, lip of vertical incision; *Bg*, horizontal semicircular canal; *e*, posterior, and *f*, anterior, margin of horizontal incision; the flap, *d, e, g*, is turned back; *St*, stapes.

advisable not to make the cut until the exact position of the scissors can be seen.

The flap is often very thick at its outer end. In order that it may more easily become attached to the underlying parts, it is well to thin it by removing most of its substance, leaving little more than skin alone.

When the incisions for the plastic operation have been completed, the operation cavity is once more swabbed out. A small tampon is left in the tympanic cavity. The flap is then grasped by its outer

edge with a forceps and laid backwards and inwards on to the bone, so that it reaches as far as possible into the cavity (Fig. 48). If it is long it may even cover a part of the floor of the tympanum. It must be held in this position until the packing of the wound is finished, and in doing this the ear must not be drawn too far forwards lest the flap be pulled out of position. I used formerly to fix the flap by a stitch to the lower angle of the wound, or to its posterior margin, but I have altogether given up this practice. It is unnecessary, since the flap is held in position by the gauze packing, and I have seen in some cases stitch abscesses and retention of secretion at the lower angle of the wound as a result. Moreover, fixation of the flap to the skin may delay or altogether prevent the closure of the wound behind the ear.

Indicates with forceps to put alone

The packing of the cavity with iodoform gauze must be done rapidly, as there is generally still a good deal of oozing from the bone. I have the vessel containing the pieces of gauze held close to the patient's head, remove the last tampon from the tympanic cavity, and then quickly pack this space, using a bayonet-shaped forceps held in the right hand to insert the gauze, while the left hand keeps the flap in its proper position. The antrum and the remainder of the operation cavity are then filled up. Finally, I turn the auricle backwards and insert several strips of gauze into the meatus, pressing them against the flap with the forceps. The flap is thus fixed in position, and the toothed forceps holding it may be carefully withdrawn from under the gauze.

For packing the middle-ear spaces I use strips of gauze with selvaged edges.* By this means the detachment of threads which might lie in the wound and delay healing is almost certainly avoided. The strips are from 1 to 2.5 centimetres wide; the length of those used for the tympanum and antrum is from 6 to 8 centimetres; longer pieces are used for the rest of the wound. Later, in the course of the after-treatment, I use narrower pieces when smaller spaces—e.g., the attic—are to be packed accurately. Another method is to fill the whole wound with one long strip of gauze the end of which is brought out through the meatus.

Primary suture of the skin wound, which was formerly rare, is now the rule. It has no disadvantages if the vertical incision in the meatus is made accurately in the line described above, so as to insure a wide opening into the operation cavity allowing of free

* These are made by Moritz Böhme, Oranienburgerstrasse, Berlin.

drainage. The amount of secretion can be kept down by using isoform, a preparation which I have found to hasten the healing considerably.

To close the retro-auricular wound I use Michel's clips. The operator raises up the skin edges with two toothed forceps, while an assistant inserts the clips. Three to five of these are sufficient, and they can be applied more quickly than the skin can be stitched up with silk or catgut. Moreover, it is possible to make them absolutely aseptic and thus exclude the danger of stitch abscess.

The wound must not be closed up if an intracranial complication is present or even if there is a suspicion that such exists, although it cannot be found during the first operation. Thus, closure of the wound is contraindicated by affection of the sinus and by hæmorrhage from the sinus started unintentionally during the operation. Further, the wound is preferably left open after the operations on the labyrinth and, of course, no stitches nor clips must be inserted if the skin over the mastoid is infiltrated—that is to say, if we have to deal with an acute exacerbation of the chronic condition.

If, for one of the reasons given above, the margins of the wound have been left ununited, they may in some cases be joined the first time the dressings are changed: healing by first intention may then be obtained, but if the closure of the wound is delayed longer, the edges of the skin must be freshened.

If a large portion of the mastoid process has been removed—for instance, in a case in which the surgeon has had to deal with a cholesteatoma extending far back and having many offshoots—it is sometimes difficult to get a good view of the whole cavity through the meatal opening. Under these circumstances the wound can be better dealt with in the early stages of the after-treatment through the retro-auricular opening. This is then allowed to close up slowly, or if, owing to the loss of substance, the edges will not come together, a special plastic operation may be performed when the whole cavity has become properly lined with epithelium.

I rarely employ Thiersch's method of skin-grafting. I tried it in several cases, but I did not find that it accelerated the healing process. The reason why I failed to get such good results from skin-grafting as others was, doubtless, because I do not undertake the radical operation unless it is very definitely indicated. Cases in which there is only circumscribed caries in the attic, on the ossicles or even in the antrum, may be cured by conservative measures.

In the cases which I operate on there is, therefore, almost always extensive carious disease or cholesteatoma present and, as a rule, the base to which the pieces of skin are to be applied is not in a condition to favour their primary adhesion. Success is so rare that an attempt either to graft or transplant skin is hardly worth making, save in exceptional cases. When I do adopt Thiersch's method I use the small spatulæ, as suggested by Jansen, for placing the strips of skin in position (Fig. 49).

(b) Körner's Method.

Many different plastic operations have been recommended (by Panse, Liebermann, Kretschmann, Schwarze, Jansen, Passow, Reinhard) which, for the most part, are intended to prevent a persistent retro-auricular opening. I will describe the method suggested by Körner, which has certain advantages over the others.

From the posterior meatal wall and a part of the concha Körner* cuts a tongue-shaped flap, of which the base is in the auricle. He proceeds as follows: First the meatus and then the whole operation cavity are packed with gauze. The packing is next removed from the meatus, but the canal remains expanded and free from folds. Two parallel incisions, reaching well into the concha, are made with a small blunt-pointed knife in the posterior meatal wall. The upper incision is close to the roof, the lower to the floor of the meatus. When the flap has been formed the packing is removed from the cavity and the edges of the retro-auricular wound are accurately sutured. The flap having been thinned, if necessary by the removal of cartilage, it is laid on the exposed bone surface, and fixed in position by fresh gauze inserted through the meatus. If the cavity in the bone is so large that there is difficulty in applying the flap, a crescentic piece of skin is cut from the posterior margin of the retro-auricular wound and the auricle is attached higher up and further back.

Körner's plastic operation has the advantage that the skin edges may be joined at once without any danger of delayed healing from imperfect drainage of the large cavity in the bone. The enlarged meatal orifice is sufficiently big to allow of proper drainage and the



FIG. 49.—
SPATULÆ FOR
SKIN-
GRAFTING.

* 'Eittrige Erkrankungen des Schläfenbeins,' S. 93 *et seq.*

application of dressings to the interior of the cavity during the after-treatment. The cicatrization of the skin wound may take place before the first dressing is removed and thus obviate the necessity for bandages round the head. Körner further claims that his method hastens the epidermization of the cavity in the bone, since the epithelium can grow out from a larger number of free edges than are provided by Stacke's operation. If, however, we compare the duration of the healing process in cases where Stacke's and Körner's methods respectively have been employed, scarcely any difference is to be observed. The disadvantages of Körner's method are the danger of perichondritis and a certain amount of disfigurement. I admit that perichondritis of the auricle may be avoided by the most rigid aseptic precautions, but it is practically impossible to prevent it with absolute certainty. Infection of the exposed cartilage may occur during the operation, although it ought not to, but as a rule, I think, it takes place during the course of the after-treatment. I have made this observation not only in the cases in which Körner's plastic method was used, but also, on rare occasions, when the vertical incision in the method first described was carried too far out on to the auricle. If perichondritis occurs, the symptoms appear four to six weeks after the operation with pain and slight redness near the margins of the wound. The danger of infection during the after-treatment is very great, for pieces of gauze soaked with secretions are frequently removed from the cavity past the wound in the auricle and the possibility of mechanical injury to the raw surface cannot be altogether excluded. Quite apart from the fact that in a large out-patient department it is impossible, owing to lack of time and space, to observe accurately all the rules of aseptic dressing, it must be remembered that the surgeon often has to deal with wounds which are infected from the beginning. In cases of large, decomposing, ichorous cholesteatomata several days' treatment is necessary before the wound becomes clean. Thus it is not possible, even with the most careful asepsis, to exclude infection of the sensitive perichondrium, and anyone who has seen the extremely disfiguring results of perichondritis will hesitate to adopt a method which may lead to it.

Of less importance, but still worthy of consideration, is the second disadvantage of Körner's method—namely, the disfigurement resulting from the enlargement of the meatal opening. Körner does not admit this and gives an illustration of an ear operated on

by his method, in which the orifice is only moderately large. I have, however, seen a whole series of cases operated on by an experienced surgeon in which the cosmetic result was distinctly bad. If the patients wore wadding in the ear, so large a piece was necessary to fill up the opening that it could be seen from a distance and passers-by had their attention attracted to the ear in spite of themselves. If a cotton-wool plug was not used, the gaping opening allowed a view into the depths of the cavity, an unpleasant sight for anyone but a specialist in ear diseases. It is beyond doubt, however, that in every operation the subsequent appearance is a secondary consideration; if a good view and access to the cavity for dressing could only be obtained by Körner's method, I should most certainly recommend it, but this is not the case. Stacke's plastic method leaves all parts of the wound freely accessible if only the vertical incision is placed sufficiently far out.

The best result is obtained when the subsequent disfigurement is reduced to a minimum. The age of persistent retro-auricular openings, of which a great many unpleasant-looking examples may still be seen, may now be said to have been left behind; but there is no reason why the surgeon should not attempt to reproduce the *status ante operationem* as closely as possible, provided it can be done without any sacrifice of thoroughness. Most of the patients treated by the first method I described do not show any signs of the extensive operative measures. Only when they are examined closely is it possible to discover behind the ear a narrow, perhaps slightly indrawn, scar which generally lies concealed in the fold between the auricle and the mastoid region. In women the hair can be easily dressed so as to conceal it. The meatal opening is of the same size as usual, and a plug of wadding in it is not large enough to attract attention.*

The plastic operation cannot always be undertaken immediately after the opening up of the bone. It is obviously contraindicated when the tissues on which the flap is to lie are unhealthy and when

* Since this was written, Körner has published his 'Lehrbuch der Ohrenheilkunde,' in which he admits the disadvantages I have pointed out. He does not now carry the incision into the concha in every case, but only when it is necessary to do so in order to make the operation cavity accessible. For a practised surgeon who does not require a large opening, he recommends Panse's method of forming the flap.

the condition of the posterior cranial fossa is not definitely known, so that there may be a question of further operative measures. Typical cases of this kind are those in which there is disease of the sinus or cerebellar dura, or a greenish-grey colour of the bone suggestive of gangrene. Under these circumstances one of three things may happen : either the flap will not adhere at all, or it will partially adhere but discharges will collect under it, or it will become firmly fixed and have to be detached again when removal of the diseased tissues under it is found to be necessary. In such cases the plastic operation should not be undertaken until the wound surface is covered with healthy granulations and no further complications are to be feared.

In cases where the bone at the upper part of the wound cavity is sound, while that at the lower part is unhealthy, I used formerly to make the horizontal incision at the junction of the posterior and inferior walls of the meatus (instead of at the junction of the posterior and superior) and turn the flap backwards and upwards. I abandoned this manœuvre, however, because the thick flap prevents a view of and access to the cavity, the region of the aditus was often not to be seen at all.

The plastic operation must, of course, be postponed if the wall of the meatus itself is inflamed, or if there is infiltration of the soft parts behind and stretching on to the auricle. I once performed the plastic operation on a boy who had a very slight otitis externa from which I anticipated no trouble. Two days later there was a slight rise of temperature and when I removed the dressings I found a small abscess in the floor of the meatus. To open the abscess the flap had to be detached and the after-treatment was thus interfered with. In cases of 'true' cholesteatoma hollowing out the bone, Körner invariably postpones the plastic operation for three or four weeks. He considers this the best means of guarding against recurrences from diseased portions of bone which may have been overlooked during the original operation.

AFTER-TREATMENT OF THE RADICAL OPERATION.

The rules for the after-treatment can only be sketched out in broad lines ; the experience of the individual surgeon will guide him in the matters of detail. The proverb 'Practice makes perfect' is particularly appropriate here. The greater the experience of the

operator, the more rapid and uneventful will the recovery be. And yet the course of events is sometimes puzzling: cases in which no mistake has been made, either in the operation or during the after-treatment, will advance to a certain point and then, in spite of every effort, the healing process comes to a standstill and the epidermization of the wound makes no noticeable progress. The general constitution of the patient has a marked effect on the length of time required for healing; the prognosis in this respect is particularly unfavourable in tuberculous subjects. It has been observed, on the other hand, that if the patient leads a healthy life at the seaside recovery takes place with great rapidity, provided that the after-treatment is carried out by a medical man with special knowledge of the subject.

The first dressing is left in position for six or eight days and during this time the patient must be kept in bed. The only indications for an earlier change of dressings are pyrexia, severe pain or iodoform eczema.

As I have already pointed out (p. 56), a slight rise of temperature may occur during the first few days, although no serious infection of the wound has taken place. This small amount of fever is not an indication for removal of the dressings. The surgeon must also be cautious in estimating the importance of pain. It may be caused by tight packing of the wound, but is generally very slight. If the patient is nervous and excitable he (or more often she) exaggerates the amount of pain, and describes it as unbearable. If the surgeon is convinced that the pain is due to the packing of the wound, especially if the temperature remains normal, he must try to quiet the patient by persuasion. Only in extreme cases is it permissible to change the dressings prematurely, as this usually has an unfavourable effect on the healing process. If the wound has to be dressed within the first few days, the flap is found to be still detached from the raw bone surface. It is pulled out of place when the gauze is removed, and it is sometimes difficult to get it back into its proper position. At the end of a week, however, the flap is firmly adherent to the underlying tissues and healthy granulations have made their appearance everywhere on the walls of the cavity.

The second dressing is left on for from three to five days, the third two or three days, and from that time forward the wound is dressed daily. The frequency with which the dressings must be changed

depends altogether on the condition of the wound, especially on the amount of discharge.

The pieces of gauze should never be allowed to become so sodden with the discharges as to be useless for drainage. It is obvious that dressing should never be long enough delayed to allow the secretions to soak out through the pads and bandages. If soaked pieces of gauze are allowed to remain too long in the wound, they tend on the one hand to set up irritation, giving rise to a too luxuriant formation of granulations, and on the other hand to destroy, by a process of maceration, the newly formed epidermis.

Another mistake, one which the beginner is especially liable to make, is packing the wound too tightly. In his endeavours to keep every part of the wound open and to prevent the undue formation of granulations which may seem to threaten at some points, he may be led on to push piece after piece of gauze as firmly as possible into the cavity. In the early days of the radical operation this was, indeed, the usual method, with the result that the dressing of the wound was an ordeal to which the patient looked forward with terror.

The patient thus suffered intensely during the after-treatment and by his involuntary movements rendered the surgeon's task exceedingly difficult. Further, not only was the desired end not attained, but, on the contrary, the granulations grew more and more freely, became continually softer and bled more at each dressing. Finally, even with vigorous sponging, the deeper parts of the wound were always obscured by blood and nothing remained but to anæsthetize the patient and scrape out the whole cavity. This had to be repeated two or three times, until at last the tendency to the formation of granulations was diminished and they remained within reasonable bounds. The length of time over which the after-treatment extended can easily be imagined. It was even sometimes impossible to bring about definite healing in young children. We see, therefore, that the disadvantages of tight packing cannot be overestimated; the beginner must always bear them in mind.

The after-treatment is nowadays almost painless, except the first few dressings; scraping out of the wound is only rarely necessary. At first it is advisable to change the tampons as quickly as possible. By practice the surgeon soon acquires a sharp eye, so that an examination lasting very few seconds is sufficient for him to decide

whether all is in order, or if, for instance, a small collection of pus at one spot indicates retention of the secretions. If the wound is exposed for any length of time during the first dressings, the deeper parts will become filled with blood which must be carefully swabbed out, the manipulation, of course, causing pain to the patient. Moreover, it is always well to avoid all unnecessary touching of the raw surface—at least until it has become covered by a protecting layer of granulations.

The following is the method I use in dressing the wound: The first dressing is done with the patient in the recumbent position, so that, should he faint, as he may easily do from the pain, there will be no unpleasant consequences. The dressings may be softened with hydrogen peroxide solution, as I described in the section on the after-treatment of simple opening up of the mastoid; but in the present case it is better to omit this expedient, since the froth formed considerably impedes the surgeon's view of the cavity when the retro-auricular skin wound has been closed. A sterile sheet is placed over the patient's neck and shoulders and the dressings are then removed as rapidly as possible from below upwards. This last point is important, especially for female patients, to prevent hairs falling down across the wound. If a retro-auricular opening has been left, the hæmorrhage from the skin edges is stopped by gentle compression for a few seconds before the gauze is removed from the cavity in the bone. The tampons are then quickly removed, first from the retro-auricular wound and then from the meatus. The whole cavity is next examined rapidly and if all is well fresh plugs are inserted. A strip of gauze 6 centimetres long and 1·5 centimetres wide, having a selvaged edge, is passed through the tympanum and aditus into the antrum; a second strip is then loosely packed in, and so on until the whole wound is filled out beyond the margins of the skin. Gauze is also introduced loosely into the meatal opening. If the skin wound was closed at the time of the operation, the metal clips must be removed before the gauze is extracted. The best method is to open them out with two pairs of toothed forceps. I have given up the small hooks specially designed for this purpose; it is very difficult to introduce them into the small holes if the skin around is swollen. Iodoform gauze is used again for packing the cavity at the second dressing but not subsequently, except in rare cases. As soon as the walls are evenly covered with granulations isoform is employed. This preparation

is manufactured by the Höchstler Farbwerke Company, and is a strong antiseptic possessing certain qualities particularly desirable in the after-treatment of the radical operation. When it is used the amount of discharge is kept down and it remains serous, rarely becoming altogether purulent. The formation of granulations proceeds evenly and not too quickly; soft, easily bleeding granulations, such as were formerly seen, are scarcely ever developed. When the wound was packed with sterile gauze in the old method, it often happened that the secretion possessed a very evil odour. With isoform properly used I have never noticed any foetor; the gauze removed from the wound tends rather to smell faintly of aniseed. Pyocyaneus infection is prevented. In one case, which had previously been treated by the old method, isoform was used with the result that the green colour of the pus disappeared within twenty-four hours.

It is thus beyond doubt that after-treatment is more satisfactory and recovery more rapid with isoform than without; but the preparation has, like every antiseptic, certain disadvantages which it is well to know. It has a caustic action, and therefore must not be used too strong, lest it destroy already formed granulations or altogether prevent them from forming, with possible necrosis of the bone as a result. I use therefore, as a rule, the 3 per cent. gauze, which can be purchased ready made up or prepared in the hospital.* Even in this strength the drug sometimes has a sufficiently powerful caustic action to give granulations a cloudy appearance. This is, however, a matter of no consequence; the surface soon becomes again red and fresh-looking. The slight cauterizing action of the isoform is an advantage because it prevents a too luxuriant growth of granulations. If this should occur, it can generally be made to cease by applying pieces of 10 per cent. isoform gauze where required. In a case of chronic suppurative otitis media I succeeded by this means in clearing away completely a mass of granulations which filled the whole meatus, and I am inclined to use isoform in such cases by way of palliative treatment.

* In the preparation of the gauze care must be taken that it contains the required percentage of isoform, and no more. I was assured by the representative of the Höchstler Farbwerke that in a particular specimen of gauze which had caused severe dermatitis, but was supposed only to contain 3 per cent. of isoform, no less than 17 per cent. had been found on analysis. The gauze I use is supplied by Hartmann's Surgical Dressing Material Factory in Heidenheim, Berlin.

Isoform gauze must not be left too long in position ; as a rule I change it at first daily, later every other day. If the packing lies too long in the wound the isoform may be used up and an evil odour arises just as when sterilized gauze is employed. I observed this specially when, in my early experiments with isoform, I used the gauze for the first dressing after simple opening up of the mastoid, and allowed it to remain in the wound for a week. After the simple mastoid operation the drug is wholly unsuitable owing to its caustic action, for a plentiful growth of granulations is just what is required for the filling up of the defect in the bone. Some patients, as might be expected, have an idiosyncrasy for isoform, and develop eczema when it is used ; but it must not on this account be altogether banished from practice, any more than iodoform has been. Personally, I have never seen a case in which isoform caused these unpleasant results.

Several aurists hold that in cholesteatoma it is advisable to leave a persistent retro-auricular opening, and they have devised various plastic operations to this end. I tried it, but failed to see any advantage from it, and I have therefore given it up again. It is a fact that a small cholesteatoma may develop in the cavity, but it can easily be removed by the natural opening. It may happen that a recurrence takes place, the secondary formation being so extensive or in such a position as to necessitate the reopening of the retro-auricular wound ; but these cases are so rare that I do not think we should be justified on that account in disfiguring every patient by leaving an opening behind the ear.

Unfortunately, there are, and always will be, cases enough in which the surgeon, whether he wishes it or not, is obliged to leave a retro-auricular opening—at any rate for some time after the operation. This will always happen when much bone has been destroyed, especially as a consequence of cholesteatoma, or when a passage must be artificially kept open behind the ear for the special treatment of such conditions as sinus thrombosis and cerebral abscess. Spontaneous closure will not then occur, and stitching of the skin edges is no longer possible ; a more or less complicated plastic operation is necessary to close up the fistula.

If the diseased bone has been thoroughly removed, if strict asepsis has been maintained during and after the operation and if no undue pressure has been exerted in packing the cavity, the process of epidermization will go on satisfactorily and quickly. Occasionally

it may be necessary to remove granulations which are growing too rapidly.

Besides the 10 per cent. isoform gauze already mentioned, I use for this purpose also lactic acid in 20 per cent. or 30 per cent. (rarely concentrated) solution which is well rubbed in. I have obtained good results by this method which was originally suggested by Grunert. The effect is sometimes surprising, the mass of granulations shrinks and soon becomes covered with epithelium; in other cases the cauterization must be repeated frequently before the desired end is attained.

I only use strong caustics, such as silver nitrate or chromic acid, in exceptional cases, owing to certain disadvantages which they possess. Solid silver nitrate always causes suppuration which sometimes destroys the newly formed epithelium and this cannot be prevented even by neutralization of the superfluous caustic. Chromic acid causes the formation of an eschar which separates but slowly from the underlying tissues. Smaller masses of granulations may be destroyed with the galvano-cautery. The resulting inflammation of the surrounding tissues acts, however, as a check on the growth of the epithelium.

There are three points to which particular attention must be paid—namely, the aditus, the neighbourhood of the fenestræ ovalis and rotunda, and the tympanal ostium of the Eustachian tube. Granulations coming from above and below not infrequently grow together in the aditus. If now the epithelium coming from behind advances over this gradually shrinking cushion of granulations, a cavity shut off from the surgeon's view may be formed behind it and may be the cause of long-continued suppuration. To prevent this the aditus must be packed with particular care. In the later stages of the after-treatment small narrow strips of gauze, filling the passage completely, should be used. Early cauterization will also prevent this unpleasant complication.

Masses of granulation tissue near the stapes and in the depression round the fenestra rotunda often defy all treatment for a long time. Removal with the curette is as much contraindicated now as during the operation. Nothing remains but to endeavour to reduce their size by using mild caustics. I must here again emphasize the danger of using the galvano-cautery in this region. The application of heat cannot be properly controlled in the depths of the wound and destruction of the membranes closing the fenestræ may very possibly result.

The closure of the ostium of the Eustachian tube is often a matter of great difficulty and may be altogether impracticable. It can be brought about more quickly if the surgeon has succeeded during the operation in preserving whatever may remain of the anterior part of the drum and laying it as a kind of flap over the opening of the tube. If this can be done, the epidermization of the rest of the tympanum often progresses with astonishing rapidity.

In some cases a thin transparent membrane is formed, growing from the promontory towards the groove for the attachment of the drum and covering the entrance of the Eustachian tube. It is, however, so fine that it is torn by the slightest touch.

Supposing that all diseased bone has been removed and any pus-containing cells in its neighbourhood have been thoroughly opened up, the cause of non-closure of the ostium of the tube is generally a chronic catarrh of its mucous membrane giving rise to a constant secretion of mucus. In most cases this condition may be cured by dropping in absolute alcohol or alcohol diluted with glycerine, or by the application of weak (10 per cent. to 20 per cent.) lactic acid solution. The swelling of the mucous membrane disappears, the discharge ceases and finally healing takes place, though unfortunately not in the manner that was desired. Every attack of acute coryza which spreads to the Eustachian tube may start the discharge afresh and treatment again becomes necessary, lest the mucous secretion should macerate and destroy a large amount of the newly formed epidermis. These are unpleasant recurrences which, although they involve no danger, are troublesome both to the surgeon and to the patient. In children adenoid vegetations, if present, must be removed. They sometimes set up suppuration in the tube.

In packing the tympanic cavity special care must be taken in those cases where there is an opening in the wall of the horizontal semicircular canal. Long after the operation the slightest touch on this spot may set up an unpleasant attack of vertigo. In many cases the region of the fenestra ovalis is equally sensitive, although it was impossible during the operation or during the after-treatment to know definitely whether there were pathological changes at this point or not. I had one patient who vomited after each dressing of the wound and I discovered that this was due to touching the bone in the neighbourhood of the fenestra ovalis with a swab.

The after-treatment must be continued on an average from eight to twelve weeks. I do not consider a patient to be completely

healed until the ear has been dry for from a week to ten days and no more scabs are formed. If the Eustachian tube remains open all secretion from it must have ceased and its ostium must be smooth and not swollen. I have seen many cases in which recovery took place within five or six weeks, but in others, again, permanent epidermization was not completed for many months. The rapidity or otherwise of the healing process depends on the patient's general condition and on the severity and extent of the bone disease. A large cavity, developed in the course of a foetid purulent otitis media associated with the formation of cholesteatoma, will not become lined with healthy epithelium as quickly as a small space depending on slight caries in the antrum or in the wall of the attic. As I hold strictly to the indications for the radical operation given in Chapter III., I rarely operate on the milder cases and therefore my average for the duration of the after-treatment is longer than that of some surgeons. When a patient has been discharged with the cavity well lined by healthy epithelium and no secretion from the wound, he must still present himself for examination at intervals. At first the newly formed epidermis is shed from time to time and the debris must be removed; otherwise, especially when cholesteatoma is present, crusts covered with dirt and wax may form and almost fill up the whole cavity. I have found the wound in this unpleasant condition in patients who neglected to return for examination within a reasonable time. But even here one thorough cleansing is generally sufficient to bring the smooth epithelium into view. It is not until some time after the operation that the epithelium ceases to proliferate and to be cast off and becomes firm, smooth and shiny. The healing process is then really at an end, and the patient does not need any further treatment or examination. He must be warned, however, not to allow any water to enter the wound when he is washing, lest the tender epidermis become soft and macerated.

Before the operation the surgeon is generally asked by the patient or his friends if it is dangerous. Hitherto it has been the rule to give a definite negative answer if the case is a 'cold' one—that is, if there are no signs or premonitions of an intracranial complication. Unfortunately, however, it is no longer possible to give this assurance with a clear conscience. Every surgeon of large experience must have seen cases in which, either immediately after the operation or somewhat later, meningitis set in without the slightest warning.

A large number of these cases of post-operative meningitis are to be found in the literature. Zeroni describes forty cases in a recently published article.* In the majority of these (29 out of the 40) the autopsy proved that the cause of the meningitis was suppuration in the labyrinth. Of this there were practically no symptoms before the operation, but according to Zeroni it undoubtedly existed in all the cases, with one possible exception. On the other hand, it must not be forgotten that an acute exacerbation and a spreading of the suppuration may be set up by the operation itself. Brieger, Hinsberg and others have suggested the concussion of the chiselling as a cause; but I believe with Zeroni that interference with the granulations in the depressions round the fenestræ, the packing of the wound, etc., are also to blame. It is also easy to imagine that the suppurative process may have advanced almost to the labyrinth and that the last barriers are broken down in the process of cleaning out the tympanum. It is often impossible to decide afterwards for how long the labyrinth was diseased. In the remaining eleven cases there were, between the dura and the bone, collections of pus which had not been discovered at the operation. The common danger in all the cases was, as Zeroni says, that 'inaccessible foci of disease were not discovered and not opened up; these foci became active through the irritation of the operation, and the process spread inwards under circumstances very unfavourable for the patient.'

How are these post-operative attacks of meningitis to be prevented? The surgeon must make it a rule to examine every case of middle-ear suppuration for labyrinth symptoms.† There is reason to hope that diagnostic methods may be further developed, so that suppuration in the labyrinth may be detected even in the latent stage. An unsatisfactory ending to the case may, perhaps, then be avoided by early opening up of the diseased region.

The clearing out of the tympanic cavity must be done with great care. Zeroni is even of opinion that granulations should not be forcibly scraped away from it at all, even at the risk of leaving behind septic matter which may set up suppurative inflammation in the mucous membrane. It seems to me that caution is here pushed too far and might eventually tend to bring the whole operation into discredit. The patient and the medical attendant who sends

* *Archiv für Ohrenheilkunde*, Bd. lxvi., S. 199.

† See Chapter V.

him to the specialist expect the chronic middle-ear suppuration to be healed within a reasonable time. If the after-treatment is too prolonged, they will doubt the efficacy of the operation.

Zeroni also utters a warning against cutting off large and thick slices of bone with the chisel, as this is liable to cause concussion. I cannot agree with him when he states that there is more temptation to do so with a flat chisel than with a curved one; on the contrary, larger pieces may be removed with a large crescentic chisel than with a flat instrument. I have already stated in the description of the operation that the bone should be removed in broad but thin slices, and that this can best be done, according to my experience, with a flat chisel. The removal of thin pieces of bone cannot possibly be dangerous.

The surgeon is often asked beforehand what effect the operation will have on the hearing. Grossmann* collected a number of cases treated in our clinic, in which the results coincided approximately with those obtained in Schwartz's and Trautmann's clinics. He reports as follows:

When the labyrinth was found by the various tests to be intact before the operation, the hearing was improved in 50 per cent. of the cases, remained unchanged in about 20 per cent., and was disimproved in about 30 per cent. If the examination beforehand showed that the internal ear was not healthy, the greatest number of cases (about 46 per cent.) remained unchanged, the hearing was improved in about 39 per cent., and was disimproved in about 15 per cent. It is therefore advisable to give a somewhat guarded prognosis as to the influence of the operation on the hearing.

PLASTIC OPERATION FOR THE CLOSURE OF A PERSISTENT RETRO-AURICULAR OPENING.

Although every effort is made to close the retro-auricular wound, a persistent opening, as we have seen, will sometimes remain. If the opening is small, paring of the edges and suture with one or two stitches are sufficient to close it. When there is a larger hole, however, a regular plastic operation is necessary, but it must not be undertaken until the edges are completely cicatrized and the operation cavity well lined with epithelium. It is, in fact, better to wait

* *Archiv für Ohrenheilkunde*, Bd. liii.

until some little time after healing has been completed, so that all danger of recurrence can be excluded. Von Mose-
tig and Moorhof * have suggested a method which I have tried successfully. Underneath the opening a skin-flap is formed, having its base at the lower edge of the hole. The flap is a little larger than the gap to be filled. Two parallel crescentic incisions are made a short distance apart, and penetrating through the superficial epithelium only. The outer layers of the skin between the two are now removed (Fig. 50); the outer incision is deepened until it reaches the fascia, and the flap is dissected off upwards. It thus possesses a marginal zone bared of epithelium. The edges of the retro-auricular opening, with the exception of the lower one, are next undercut



FIG. 50.—MODIFIED MOSETIG-MOORHOF OPERATION FOR THE CLOSURE OF A PERSISTENT RETRO-AURICULAR OPENING.



FIG. 51.—MOSETIG-MOORHOF OPERATION—continued.

and levered slightly up from the underlying tissues (Fig. 51). The flap is then turned over so that its former outer surface looks inwards; its margins are gently pushed beneath the undercut edges of the opening, and it is fixed in position with a few fine catgut sutures (Fig. 52). Finally the sides of the wound caused by the dissecting up of the flap are drawn together (Fig. 53). The raw surface of the flap, which is now turned outwards, is allowed to heal by granulation, or covered with skin by Thiersch's method.

With regard to this operation, it is to be remarked that the edges of the retro-auricular opening cannot always be undercut and lifted up from the underlying tissues. In these circumstances the surgeon

* *Monatsschrift für Ohrenheilkunde*, 1899, No. 1.

has to content himself with paring the edges and suturing the flap thereto. Further, the skin below the opening sometimes consists altogether of scar tissue, which cannot be used for plastic purposes, and in these cases I have taken the flap from the posterior surface of the auricle. On one occasion, when the hole was small, I formed the flap in this way, and then fixed the concha down over it to the posterior margin of the opening.

Passow* has suggested another plastic operation. The following is a description of it, taken from Trautmann's† book on the operations in this region:

‘When the field of operation has been carefully cleansed and rendered as nearly sterile as is possible without injury to the newly



FIG. 52.—MOSETIG-MOORHOF
OPERATION—continued.



FIG. 53.—MOSETIG-MOORHOF
OPERATION—completed.

formed epithelium, a strip of gauze is inserted into the cavity to prevent blood from collecting in the deeper part of the wound. Two small vertical incisions are first made, one in the middle of the upper, the second in the middle of the lower margin of the opening, each incision being 4 millimetres in length, and extending about 2 millimetres down into the funnel-shaped hollow (Fig. 54). Two crescentic incisions are then made, an anterior and a posterior, beginning above and ending below in the small vertical cuts, and situated at about 4 millimetres from the edges of the opening. The posterior incision must reach down to the periosteum, the anterior to the perichondrium. The anterior flap thus formed is dissected up with a scalpel, the

* *Zeitschrift für Ohrenheilkunde*, Bd. xxxii., S. 224.

† ‘*Leitfaden für Operationen am Gehörgang*,’ 1901, S. 81.

posterior levered off the bone with a raspatory. The soft parts over the mastoid must also be separated from the bone, so that the skin may be capable of stretching across the wound when the final stitches are drawn tight. The flaps have now been detached from the outer surface of the skull, but they are connected by broad bases to the soft parts at the edges of the cavity, and thus they receive a sufficient supply of blood. They are next turned over, and two



FIG. 54.—PASSOW'S PLASTIC OPERATION FOR THE CLOSURE OF A PERSISTENT RETRO-AURICULAR OPENING.

separate catgut sutures are passed from above downwards through each flap in such a manner that four ends of the catgut emerge from the anterior and four from the posterior flap (Fig. 55). The numbers 1 and 2 in the figure mark the first suture, the numbers 3 and 4 the second. Stitches running vertically can be put in easily with an ordinary slightly curved needle, while in the antero-posterior direction a very small and a very much curved needle is necessary on account of the prominence of the mastoid. When all the sutures

have been put in, the lower ends of the upper stitches (No. 2) are held aside by an assistant, while the upper ends (posterior No. 1 and anterior No. 1) are knotted together across the opening. The No. 2 ends are then knotted, and the process is repeated with Nos. 3 and 4. Finally, the skin is sutured with silk across over the raw surface (Fig. 56). The gauze inserted into the cavity is removed through the meatus and a fresh plug inserted. An aseptic dressing is put on and allowed to remain in position for five days.'

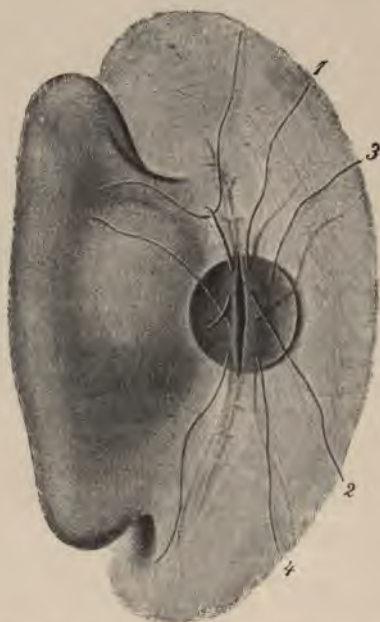


FIG. 55.—PASSOW'S PLASTIC OPERATION—*continued*.

The two flaps may be united equally well with ordinary stitches, as Passow himself now does. A fine needle very much curved is used, and care must be taken that it is passed only through the subcuticular tissue and does not appear on the epithelial surface of the flap, in order that the margins of the wound may not be inverted. Further, it is advisable to undercut the edges as far as possible from the wound, and to raise the skin alone posteriorly, and not the soft parts down to the bone. This last point is particularly important if Michel's clips are to be used, because a thick mass of skin and

subcutaneous tissue cannot well be raised up into a fold for their insertion. The incisions for the formation of the flaps form four little projecting corners, two at the upper and two at the lower end of the wound, and Passow now pares these off with a scissors to allow of better adaptation of the skin margins.

I believe that Passow's method is suitable for the closure of very large openings, but in such cases the incisions must reach farther upwards and downwards and the skin must be separated to a greater

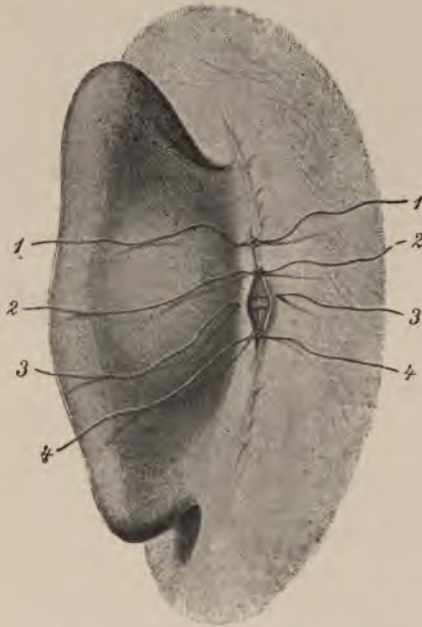


FIG. 56.—PASSOW'S PLASTIC OPERATION—completed.

extent anteriorly and posteriorly. Again, it is necessary to put a stop to all hæmorrhage and oozing. In one of my cases the skin covering was separated from both flaps by hæmorrhage after the operation. The whole of this operation can be carried out under local anæsthesia.

I injected paraffin in several cases with the object of closing up the small gaps behind the ear, but I was not satisfied with the results. I have therefore given the method up and do a cutting operation in every case.

CHAPTER V

LABYRINTHOTOMY

1. INDICATIONS—2. THE OPERATION.

1. INDICATIONS.

SUPPURATION may advance from the middle ear through the labyrinth to the brain. The comparative frequency with which the infection travels by this route I have shown in a statistical study of sixty-three cases of uncomplicated diffuse purulent meningitis which were treated in the University Otological Clinic in Berlin between the years 1881 and 1900. In twenty-two cases of this fatal disease the cause was a labyrinth suppuration. Hinsberg* estimates the mortality from diffuse labyrinth suppuration at 15 to 20 per cent. at least.

The perforation into the labyrinth may occur through the fenestra ovalis, the fenestra rotunda, the promontory, or the horizontal semicircular canal—more rarely through the posterior or superior canal. The aqueductus vestibuli, the aqueductus cochleæ and the internal auditory vein carry the suppurative process farther, or else it makes its way directly through the diseased bone surrounding the labyrinth to the brain and its membranes.

Labyrinth suppuration is thus very dangerous to life, altogether apart from the fact that it may lead to disturbances or abolition of the functional utility of the ear. We must therefore use every effort to cure it. The removal of all diseased tissue from the middle ear is, as we shall see, sometimes sufficient for this purpose; but in other cases the disease progresses and the surgeon is surprised, perhaps after several weeks, by the sudden onset of meningitis. The patient's life cannot be saved and the autopsy shows that the fatal meningitis took its origin from the labyrinth.

* 'Verhandlungen der Deutschen Otologischen Gesellschaft,' 1906.

It seems, therefore, that in order to avoid this calamity, which cannot be foreseen, we should open up the labyrinth in every case showing the slightest symptom of suppuration therein. But this practice will only increase the danger. Many healthy labyrinths would be opened and become infected from the operation, or would, at least, be rendered functionally useless. In my opinion the opening of even the perilymphatic space is always dangerous, more especially when the surrounding tissues are in a state of suppurative inflammation. Hinsberg has attempted to prove by statistics the safety of the labyrinth operation, and Freytag* has collected for him all the hitherto published cases and the still unpublished ones from the University Otological Polyclinic in Breslau. According to these statistics there is only one case of death from the operation to sixty-nine cases cured. In two other cases Freytag assumes that the fatal complication was present, although it could not be demonstrated before the operation. This is a very low percentage mortality and at first sight it seems that Freytag is justified in his statement that 'the operation in the labyrinth is not very dangerous,' and yet I think that this conclusion is wrong, or at least premature, for the number of cases operated on is still much too small. It is always difficult to set these questions at rest by a statistical collection of the cases from the literature; some instances can always be found which point to a conclusion on either one side or the other. These are unimportant if we are dealing with large numbers of cases, but when the total is small they may have a marked influence on the results. The operator himself is not always able to decide whether a good or bad result has occurred *post* or *propter operationem*. And even if he is able definitely to throw the blame for a fatal ending on the operation, he may perhaps be tempted to omit the publication of that particular case. I am therefore of opinion that the number of published fatal cases from the labyrinth operation corresponds at least to the number which really occurred.

new In his first publication† on labyrinth suppuration, Hinsberg mentions two cases of opening of the healthy vestibule; both patients recovered in spite of unfavourable conditions in the wound. Freytag adds seven cases in which the healthy labyrinth was opened up for symptoms of Ménière's disease (there being no otitis media) without evil results. In these last cases the operation was done on

* *Zeitschrift für Ohrenheilkunde*, Bd. li., S. 341.

† *Ibid.*, Bd. xl.

healthy tissues, so that there could have been no danger of meningitis unless secondary infection of the wound had occurred.

The non-occurrence of meningitis in Hinsberg's cases may very well have been due to other causes than those which he adduces to prove that intentional is less dangerous than unintentional opening of the labyrinth. The fluid may have a direct bactericidal action and, moreover, in rushing out it tends mechanically to prevent the entrance of organisms. Similarly, injuries to the membranes of the brain which open the subarachnoid space are undoubtedly dangerous although rarely followed by meningitis. I remember one such case in which meningitis occurred, but in that instance the outflow of cerebro-spinal fluid was very slight. Admittedly, a large opening into the vestibule is more favourable than a small tear in the annular ligament of the stapes; but to obtain perfectly free drainage from the labyrinth we should have to remove the entire internal ear in every case, and this is out of the question when parts of it—*e.g.*, the cochlea—are still capable of performing their functions.

I am convinced that opening of the labyrinth is always dangerous for the patient. I may possibly have an exaggerated idea of the danger, but I think I have shown that it undoubtedly exists.

The surgeon may thus find it hard to decide whether he should operate or not; but this difficult question is made somewhat easier by the fact that spontaneous recovery is not only possible, but may even be said to be the rule, in certain types of labyrinth disease.

Jansen was the first surgeon who gave particular attention to the surgery of the labyrinth. He collected 170 cases of labyrinth affections, which were treated in Lucae's clinic between 1889 and 1896, and first pointed out the frequent occurrence of carious perforation of the wall of the horizontal semicircular canal. The lesion was present in 132 cases. Lucae published from the same clinic a report of 50 cases of labyrinth disease up to 1899, and in 32 of these the wall of the horizontal canal was perforated. I collected 57 further cases up to 1906, with 43 perforations.

Of all the deaths in the clinic, 8·3 per cent. were due to labyrinth suppuration, and that this proportion was so small was due, I believe, to the large preponderance of cases of perforation into the horizontal canal. I agree with Hinsberg that in these cases the disease was circumscribed, but Friedrich* does not consider that the

* 'Die Eiterung des Ohrlabyrinths,' S. 51.

number of microscopical examinations made up to the present provides sufficient evidence for the assumption. Lately Hinsberg* has collected a number of cases which, in my opinion, decide the question. The clinical course of the disease was in favour of my view; frequently the finding of the labyrinth lesion was a surprise, as it had caused practically no symptoms beforehand, while in other cases the symptoms disappeared so quickly after the operation that the question of extensive disease could not arise.

Some authorities (Brieger, Kümmel, Panse) doubt that fistula of the semicircular canal occurs frequently, and consider that my conclusions are based on inaccurate observations. They point out that the lesion is very rarely found in the cadaver. This depends, however, as Hinsberg has stated, on the fact that circumscribed perforation of the canal practically never causes the death of the patient. I agree with Brieger that the presence of an opening into the lumen of the canal does not necessarily mean that there is disease of its wall; I have seen it fairly often in dissections of normal bodies. I also admit that a small cell broken open or a congenital defect of the wall might lead the observer astray; but, speaking generally, I can say with absolute certainty that I have not been deceived in any large number of cases. A mistake is quite out of the question in cases where the perforation is so large that the groove of the canal comes into view as soon as the granulations have been removed from the wound. Even a smaller perforation presents such a typical picture that it is rarely a matter of doubt for a practised observer, if the illumination is good and the hæmorrhage has been brought to a standstill. And, finally, the clinical appearances cannot be explained in any other way. On admission the patient often shows nystagmus, and is found to be either then suffering or to have suffered from dizziness. When the middle ear is opened up, a blackish discoloured spot is seen on the ridge of the horizontal semicircular canal, and there is no other perforation into the labyrinth. After the operation the vertigo and nystagmus disappear and may be sometimes induced during the after-treatment by touching the semicircular canal.

Or, again, a patient may have marked vertigo and nystagmus when the tragus is pressed upon, and the operation brings to light the typical appearance of perforation into the semicircular canal.

* 'Verhandlungen der Deutschen Otologischen Gesellschaft,' 1906, S. 42.

No one can justly state that in all these cases mistakes have been made, for this would mean that the labyrinth was opened at some other point—*e.g.*, at the fenestra ovalis—and the whole course of the cases is against this assumption. If it were correct, we should have had to report a much larger percentage mortality. I am surprised that such careful observers have so seldom seen fistulæ of the semi-circular canals. This is perhaps explained by the fact that we found cholesteatoma in about 45 per cent. of the cases radically operated on in our clinic, and it is just this form of suppurative otitis media which most commonly leads to erosion of the bony walls. Pressure necrosis of even the compact bone of the labyrinth capsule is caused by the growth spreading from the attic, especially at points, as in the aditus, where it has to force its way through a narrow passage. If the bone is thin, the membranous lining of the horizontal semicircular canal will soon be reached; if the bone is thick, the ridge projecting into the aditus will soon become so much worn away as to be unrecognizable. True perforations due to caries are much rarer. I believe that even the doubters will sooner or later be convinced of the comparatively frequent occurrence of fistula of the horizontal semicircular canal.

Experience teaches us that these lesions are relatively not very dangerous, and I therefore consider that it is a mistake to enlarge the opening and seek to follow it into the vestibule in every case. If this is done, protective adhesions may be broken down and the circumscribed labyrinth affection turned into a generalized one. In my opinion it is exceedingly rare that perforation takes place in the opposite direction — namely, secondarily to suppuration in the vestibule.

Even diffuse inflammation of the labyrinth with severe symptoms may heal spontaneously without outside help. Parts or the whole of the bony capsule may be cast off as a sequestrum, and yet diffuse affection of this region must be regarded as a very grave complication and every effort must be made to cure it as soon as possible lest meningitis should suddenly set in.

The question now arises whether it is possible to distinguish with certainty between circumscribed and diffuse labyrinthitis, and the answer is, unfortunately, in the negative. A perforation of the wall of the horizontal semicircular canal, which at first seems to bode no ill, may lead to the death of the patient from meningitis or cerebellar abscess. The post-mortem examination in such a case shows

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suppuration of the vestibular apparatus, the cochlea, or even of the whole labyrinth. In every case of suppurative otitis media in which an operation has been decided on and where there are any symptoms pointing to labyrinthitis, we must endeavour to ascertain before the operation whether disease of the labyrinth exists and, if so, whether a part or the whole of it is affected.

Hinsberg states that the symptoms vary according as the diseased organ is still capable of performing its functions or is completely destroyed. In the former case there are symptoms of irritation, in the latter of loss of function. Irritation of the cochlea produces subjective noises, while irritation of the vestibular apparatus sets up vertigo, disturbances of equilibrium, nystagmus, nausea and vomiting. If the cochlea is destroyed, deafness results; while, after destruction of the vestibule and the semicircular canals, we get loss of equilibrium, but *without* dizziness or nystagmus. 9

To establish the presence of these functional troubles complicated methods of examination have been worked out by Stein, Panse, Wanner, Hinsberg and others. This is not the place, however, to go into these points in detail; the discussion would lead us too far and lies beyond the scope of this work. The results which have been hitherto obtained by these methods of examination are not altogether free from an element of doubt; further research is necessary before we can decide whether they lead to certain conclusions or not.

I must not omit to mention an important objection to one of these tests raised by Denker at a recent meeting of the German Otological Society. I altogether agree with Denker that Stein's hopping test causes far too much concussion to the whole body, and therefore to the labyrinth. I believe that it may determine the spread of a previously localized suppuration, and is therefore too dangerous to be justifiable.

I will mention here only one other method of examination—namely, that suggested by Barany* for testing the vestibular apparatus. The method is without danger to the patient and perhaps also gives sure results, though on this last point further investigation is necessary. If a normal ear, or one in which there is

* 'Verhandlungen der Deutschen Otologischen Gesellschaft, 1906,' S. 147, and 'Untersuchungen über den vom Vestibularapparat des Ohrs reflektorisch ausgelosten rhythmischen Nystagmus und seine Begleiterscheinungen' (Oscar Coblentze, Berlin, 1906).

suppurative otitis media, but a healthy vestibular apparatus, be syringed with water at a temperature lower than that of the body, circular nystagmus towards the opposite side is developed. If, on the other hand, the temperature of the water is above that of the body, the nystagmus is towards the ear syringed. When, in a case of suppurative otitis media, no nystagmus is developed by either hot or cold water, it is a sign that the vestibular apparatus has been destroyed. Barany holds that spontaneous nystagmus as a sign is only of value when observed in conjunction with this test of the power of reaction of the vestibular organ. The reason for this view is plain, for when the vestibular apparatus has lost all power of reaction in a case of acute or subacute labyrinth suppuration, spontaneous nystagmus may be developed from the sound side.

The cold nystagmus may be set up by water very little under the body temperature (a temperature of 95° F. is sometimes low enough when the drum is absent); for this reason, and also because the water is not injected under pressure, Barany's test is without danger.

As to the indications for opening up the labyrinth, I depend mainly on the appearances found on operation, following the principles set out below :

If a fistula is found in the wall of the semicircular canal I leave it alone, even if labyrinth symptoms are present; but if the symptoms appear for the first time after the operation, or if the operation leaves them as bad or worse than before, opening up of the labyrinth is justified, especially if severe general symptoms pointing to a commencing meningitis also set in.

Further, if meningeal symptoms are present and other intracranial complications which might cause them can be excluded, the labyrinth must be opened, even though it is impossible to localize the perforation into the horizontal semicircular canal.

Immediate and free opening up of the vestibule is indicated when the radical operation discloses a large cup-shaped opening filled with granulations leading into the horizontal semicircular canal.

It should also be undertaken if the stapes is destroyed, the fenestra ovalis filled with granulations, or if pus is seen exuding from the vestibule itself.

The cochlea should not be opened up unless there is absolute deafness. The basal turn of the cochlea may sometimes in these cases be seen to be diseased. The deafness must, of course, be a recent condition; if it has existed for some time we may assume

with fair certainty that all active disease in the cochlea is at an end.

When a cerebellar, an extradural, or a subdural abscess is exposed, and the labyrinth is found to be diseased, it must be opened up. Sequestra formed in the bony wall of the labyrinth are not removed unless they have become completely separated.

Following these indications fifty-seven cases of labyrinth disease were operated on in the Berlin University Otological Clinic between April, 1899, and March, 1906. Of these, forty-three showed fistula of the semicircular canal. In two cases we removed a sequestrum of the semicircular canal and in one a sequestrum of the whole labyrinth. In one case of perforation of the semicircular canal and suppuration in the vestibule a large portion of the cochlea separated off afterwards, in another sequestra of the canal and the cochlea were cast off. The semicircular canal and the vestibule were affected in nine cases (besides the one mentioned above), and in three of these suppuration was also present in the cochlea. Eleven of the patients died: four from the labyrinth suppuration, two from purulent meningitis, one from serous meningitis and one from cerebellar abscess. Of the forty-three patients with perforation of the semicircular canal two died, but from causes in no way connected with the disease of the labyrinth. Seven operations were performed on the labyrinth, consisting of opening up the vestibule and the semicircular canals; in one case the basal turn of the cochlea was exposed. Of these seven one patient recovered. In another case the labyrinth suppuration was cured, when the patient died of abscess in the temporal lobe. Three died from causes independent of the labyrinth suppuration, one of serous and one of purulent meningitis starting from the region of the labyrinth. In the last-mentioned case the vestibule and semicircular canals when opened appeared normal to the naked eye, although the clinical signs and the appearances (fistula of the horizontal canal) pointed to the presence of labyrinth suppuration.

THE OPERATION.

An indispensable condition for the success of the operation is strong illumination of the region of the labyrinth. A simple electric head-lamp is sufficient if it is bright and has a good lens. Further, the whole field of operation must be freely exposed. Enough of the posterior meatal wall (the so-called 'spur') must be removed to

bring the region of the fenestra ovalis clearly into view and to make the bony canal of the facial nerve recognizable.

I shall first consider the cases in which the pus has made for itself a broad passage from the horizontal semicircular canal to the vestibule. If it is possible by careful probing to find a large perforation filled with granulations in the anterior limb and the ampulla of the horizontal semicircular canal, the surgeon must first scrape away the granulations with a small curette, taking care not to injure the facial nerve in the aqueductus Fallopii. The vestibule is then further exposed *via* the semicircular canal by chiselling away a little more of the bone above and behind the facial nerve. The stapes must now be sought for and removed if present, and subsequently the fenestra ovalis is enlarged with a fine chisel downwards and backwards towards the fenestra rotunda. From there it is possible to reach the basal turn of the cochlea by chiselling away the promontory. In one of my cases of cholesteatoma, in which facial paralysis was present before the operation, I was unable to spare the nerve. The growth had forced its way through the fenestra ovalis into the vestibule and had also invaded the ampulla of the horizontal semicircular canal. The openings into the vestibule above and below the Fallopian canal were not large enough to allow of complete removal of the cholesteatomatous masses and I was obliged to remove the bony bridge containing the nerve.

If the labyrinth symptoms have all disappeared at the time of the operation, the granulations are carefully scraped out of the fistula and the instrument used is not allowed to penetrate more deeply. We may assume that the focus of disease in the labyrinth has been shut off by adhesions, and if these are broken down by using instruments too energetically the path to the subarachnoid space will be again opened up to the infective process. In a case reported by Jansen granulations were scraped out of a labyrinth which had been opened a week before, with the result that the patient developed meningitis and died.

In some cases we find that the pus has made its way out through the fenestra ovalis, or that there is no fistula at all, although labyrinthotomy is undoubtedly indicated by the symptoms. Under these circumstances either the horizontal canal or the fenestra ovalis can be chosen as the starting-point for reaching the labyrinth. Jansen opens the posterior limb of the canal and traces it to the vestibule, removing the bone in an upward direction. I have

succeeded, as Hinsberg formerly did, in following the anterior limb into the vestibule without meeting with any serious difficulties. The semicircular canal is best opened at the most prominent part of its ridge which is usually easy to see. If the aqueductus Fallopii has been clearly defined beforehand, it will not be injured. I work with a fine chisel, not with a burr, which, according to Bourguet,* is liable to slip into the path of least resistance—that is, towards the canal for the facial nerve. Hinsberg† now adopts the following method: He introduces a fine burr into the fenestra ovalis, and removes the lateral labyrinth wall downwards as far as the fenestra rotunda. In doing this the lower turn of the cochlea is opened at the same time. For the opening up and clearing out of the cochlea Hinsberg recommends the chisel, since the bone-dust made by the burr prevents a clear view of the parts. The dangers in this stage of the operation are injury to the facial nerve from the burr slipping upwards, and lesion of the carotid in the region of the apex of the cochlea, or even at the promontory, if the vessel is abnormally situated, and the instrument happens to ‘race’ at that point. Further, if the burr is used rashly in the cochlea it may slip through the lamina cribrosa into the internal auditory meatus.

Bourguet’s protector‡, or a bent probe, is next inserted through the fenestra ovalis, and passed up under the aqueductus Fallopii until its end comes to lie in the anterior limb of the horizontal semicircular canal. The wall of the canal is then removed with the burr.

If suppurative labyrinthitis is present in connection with a cerebellar or extradural abscess, Jansen§ removes the posterior part of the mastoid process and the roof of the antrum, with the superior border of the petrous bone as far as the median wall of the antrum. He then removes the posterior half or two-thirds of the superior semicircular canal, also as much of the posterior semicircular canal as is necessary, and then opens up the vestibule from behind by removing the posterior half of the horizontal semicircular canal. He points out that in this operation the petrosal sinus and the

* ‘Anatomie Chirurgicale du Labyrinthe’ (*Thèse de Toulouse*, 1905, and *Annales des Maladies de l’Oreille*, T. xxxi.).

† ‘Über Labyrinthoperationen’ (*Verhandlungen der Deutschen Otologischen Gesellschaft*, 1906).

‡ Made by Collin, Rue de l’École de Médecine, Paris.

§ Blau, ‘Encyklopädie der Ohrenheilkunde,’ S. 205.

dura ought not to be injured if proper care is taken ; but a lesion of the bulb of the jugular vein is a very possible accident if the vessel reaches high up into the petrous bone to a point behind the vestibule.

Neumann's* method is similar. He first opens up the posterior fossa of the skull in front of the sinus and then removes the posterior surface of the petrous bone in thin layers as far as the internal auditory meatus. The vestibule and semicircular canals are thus exposed from behind. The facial nerve cannot be injured, but it is possible, as in Jansen's method, to damage the superior petrosal sinus or the bulb of the jugular.

I agree with Hinsberg that this method is particularly suitable for difficult cases, and it, or Jansen's, may be followed with advantage in dealing with cerebral complications in the posterior fossa, which have been caused by disease in the labyrinth.

* *Archiv für Ohrenheilkunde*, Bd. lxvi., S. 69.

PART II

*OPERATIONS FOR THE INTRACRANIAL
COMPLICATIONS OF OTITIS*

CHAPTER I

OPERATIONS FOR EXTRADURAL AND SUBDURAL ABSCESES

DIAGNOSIS: (a) Extradural abscess; (b) subdural abscess—THE OPERATION.

DIAGNOSIS.

(a) Extradural (Epidural) Abscess.

WHEN suppurative inflammation of the petrous bone spreads into the cranial cavity the dura is usually first affected, either by direct contact with the diseased bone or by spread of the inflammation from a distant focus through canals or lacunæ in the bone. Inflammation of the outer surface of the dura mater (external pachymeningitis) is first developed. The severity of the original affection will determine whether the inflammation remains confined to the dura or progresses farther. If the suppurative process does not pass beyond the outer membrane an extradural abscess is formed. These are found more frequently in cases of acute than of chronic middle-ear suppuration. The amount of bone destruction varies. We may find a cavity bounded on the inner side by the membranes, or a fistulous track may lead into the abscess; in rare cases it may be impossible to trace a communication between the abscess and the focus of disease in the bone.

Extradural abscesses are more often seen in the posterior than in the middle cranial fossa. In the former they are found, as a rule, as perisinous abscesses, which are particularly liable to spread towards the middle line to the adjacent cerebellar dura. Abscesses situated on the cerebellar dura only are more rare and, as a rule, are the result of a labyrinth suppuration or of empyema in the endolymphatic space. This last condition seems, from modern

researches (Wagener*), to occur much less often than might be supposed from a study of the literature.

When an abscess occurs in the middle fossa, it is generally situated over the tegmen antri and tegmen tympani. In rare cases a collection of pus forms at the apex of the petrous bone, generally finding its way thither through the carotid canal. The prognosis in these cases is very unfavourable.

When the abscess is newly formed as a result of acute middle-ear suppuration, the dura, although covered with soft granulations, may appear almost normal itself except for a slight hyperæmia. As a rule it is thickened, reddish-grey in colour and has granulations firmly attached to it. The membrane may be raised off the bone for a considerable distance around an extradural abscess in the middle fossa may extend into the posterior fossa and *vice versa*. I saw one patient who had a fistula discharging pus at the posterior border of the mastoid process for several months before he came to me for treatment. The operation revealed an extradural abscess which had started from the posterior cranial fossa and reached almost to the top of the head. The dura was widely separated from the bone and the intervening space was filled with spongy granulations.

In chronic middle-ear suppuration, especially when it is associated with cholesteatoma, the dura and the neighbouring bone are often of a grey-green colour, while granulations are almost or entirely absent. In these cases, too, the abscess shows but little tendency to spread over the surface of the membranes; local destruction of the dura is more common. It is not possible to diagnose an extradural abscess with absolute certainty before the operation. Most of them, especially if they are small, cause no symptoms or symptoms of such a general nature (*e.g.*, headache, general malaise) that no definite conclusion can be drawn from them.

Symptoms of cerebral compression are relatively rare; local cerebral symptoms (crossed paralyses and disturbances of sensation, aphasia) are, according to Körner, only to be observed in children. Rigidity of the neck muscles is only of importance in the diagnosis of abscess in the posterior fossa when cerebellar abscess and meningitis can be excluded with certainty.

When an abscess is present in the posterior fossa, we find sometimes swelling and infiltration behind the mastoid, while the soft

* *Archiv für Ohrenheilkunde*, Bd. lxxviii., S. 273.

parts covering the process itself—or, at any rate, its anterior part—are altogether free. I have seen this sign fairly frequently, but in at least half of the cases I found disease of the bone only, without any perforation into the cranial cavity. Körner states that an extension of the suppuration by way of the mastoid emissary vein may manifest itself as an inflammatory infiltration and oedema of the corresponding part of the occipital region of the scalp. Similarly an extradural abscess over the temporal lobe may set up oedema of the soft parts when it is about to break through or has already perforated the squamoid. As we have already seen (p. 30), the extension outwards of a focus of suppuration in the mastoid itself, or between the two layers of the superior meatal wall, may lead to infiltration over the squamoid and present the same appearances as those described above.

When in the course of acute suppurative otitis media a free flow of purulent secretion sets in, we may conclude that a large cavity is present in the mastoid serving as a reservoir of pus. Experience shows that when such a cavity has existed for some time, the dura is already exposed at some point, generally in the posterior fossa.

(b) Subdural (Intrameningeal) Abscess.

When the pus perforates the dura, the internal pachymeningitis set up may in rare cases have the effect that an abscess forms between the dura and arachnoid, while neither the arachnoid nor the pia mater is infected. We have then to deal with subdural suppuration, or, if the dura becomes adherent to the other membranes so as to shut in the pus, with a subdural abscess. Relatively to the other intracranial complications of otitis, a pure subdural suppuration—that is, one not combined with a leptomeningitis or a cerebral abscess—is very rare. The reason is that the pus does not long remain stationary in the subdural space.

In the last edition of his book on the cerebral complications of otitis Körner collected together all the cases—sixteen in number—known up to that time. Of these, however, two which ended in recovery—Jansen's case and Lucae's case—were considered by these surgeons to be cases of localized meningitis. Later Suckstorff and Henrici* reported from Körner's clinic a case of chronic middle-ear

* *Zeitschrift für Ohrenheilkunde*, Bd. xliv., S. 161.

suppuration with a large extradural abscess in the middle fossa and necrotic destruction of the dura, in which suppurative arachnoiditis and subdural suppuration at points curiously far apart had occurred. Manasse* mentions briefly in a paper on the operative treatment of meningitis secondary to ear disease a case of subdural abscess in the posterior fossa. A large quantity of thick pus was allowed to escape by puncture and incision of the dura. The autopsy showed neither cerebral abscess nor meningitis.

Hölscher† described a case of subdural abscess in the middle fossa which he considers to have originated four years previously. Although several operations were performed, it was only found post-mortem. Guder, Chavasse and Pontoppidan have also published papers on this subject.

I published three cases‡ from Lucae's clinic. In view of the rarity of subdural suppuration relatively to the other cerebral complications of aural origin, I will give here a fairly full note of one of these cases which shows the typical pathological picture very clearly.

A man of thirty-three, who had suffered for years from suppurative otitis media on the right side, developed severe earache, headache and fever; later pains, stiffness in the neck, partial unconsciousness and restlessness were added. On admission, the patient was somewhat dazed and had to think for some time before he could give correct answers to our questions. There was well-marked rigidity of the neck muscles, the temperature was 104·6° F., the pulse 90. We had thus a set of symptoms which suggested meningitis very strongly. The right mastoid was very tender on pressure; the right tympanic membrane was intact, except for a small perforation in Shrapnell's membrane, from which a granulation covered with a little fetid pus protruded. The operation, performed soon after the patient's admission, brought to light a large cholesteatoma which had already partially destroyed the posterior wall of the meatus, so that Nature had, to a certain extent, already carried out the radical operation. In the region of the posterior vertical semicircular canal a granulation had buried itself deeply in the bone, and on following this up the posterior fossa of the skull was

* *Zeitschrift für Klinische Medizin.*, Bd. lv.

† *Die otogenen Erkrankungen der Hirnhäute*, Marhold, 1905.

‡ Cases I. and II. in the *Lucae Festschrift*, Springer, 1905; Case III, *Verhandlungen der Berliner Otologischen Gesellschaft*, 1903.

opened. The dura seemed to have been adherent at this point; it showed a small slit, 2 millimetres in length, from which what appeared clear fluid flowed. The bone of the tegmen antri and tegmen tympani seemed to be healthy.

In order to confirm the diagnosis made from the clinical picture, to which the condition found on operation corresponded, I performed lumbar puncture, but found an almost clear fluid containing but few pus corpuscles and no bacteria. The temperature decreased after the operation, but otherwise there was no alteration in the condition of the patient. He continued restless and slightly dazed; the stiffness of the neck muscles increased. On the supposition that there was some pathological process in the posterior fossa, possibly a cerebellar abscess, I exposed the cerebellum further on the fourth day after the first operation and explored the brain substance, but without result. Puncture of the sinus was negative and a second lumbar puncture produced clear fluid as before. The patient became very drowsy and died two days later, the temperature having risen to 104·6° again shortly before the *exitus*.

The result of the autopsy surprised us: we found neither meningitis nor a deep cerebellar abscess. When the dura had been incised, several tablespoonfuls of thick, curdy, fetid pus flowed out from the right side, so that we at first thought of a perforated abscess of the temporal lobe. On turning back the dura its inner surface was found to be covered with masses of inspissated pus and similar masses were found on the floor of the middle fossa. The surface of the cerebral hemisphere appeared ulcerated at some points, as if the patient had superficial suppurative encephalitis. At the base of the temporal lobe, in the posterior part of the occipital lobe and on the frontal lobe were deep hollows varying in size from that of a walnut to that of a small apple. These depressions had at some parts of their circumference sharp edges and were connected together by flattened bands of inspissated pus varying in width. This coating, which had the appearance of a pyogenous membrane, especially over the temporal lobe, could be scraped away with a scalpel to expose perfectly normal-looking pia mater underneath. The pia was not infiltrated with pus at any point. The cerebellum and the left hemisphere of the cerebrum were quite healthy. The case was therefore one of extensive uncomplicated subdural suppuration and we had to seek for the point where the infection had passed from the petrous bone to the dura.

When the membrane was lifted up from the floor of the middle fossa, a small opening was found in the bone a little to the median side of the tegmen antri, and corresponding to a small fistula in the dura filled with granulations. The bone around the gap was normal in colour and perfectly healthy, a proof that the opening was congenital, and had not been caused by the suppurative process. The perforation had been overlooked during the operation owing to the healthy appearance of the surrounding bone, and for this reason there had been no grounds for supposing that the middle fossa was diseased. The appearances disclosed by the operation seemed rather to indicate that the suppurative process had attacked the cerebellum. The increasing stiffness in the neck confirmed me in my opinion, for this symptom is characteristic of affections of the cerebellum and is rarely seen when only the anterior part of the brain is diseased. It is questionable whether exposure and incision of the dura covering the temporal lobe would have saved the patient's life. If the focus of suppuration was confined to the temporal region, a good result might have been obtained; but I do not believe we could have provided sufficiently free drainage for the extensive suppuration, encapsuled to some extent and yet spreading over the occipital and frontal lobes. The bands of inspissated pus and the membrane-like formation seem to indicate that even when the patient was admitted the process had already extended very widely.

In the second case, one of chronic suppurative otitis media on the left side, there was amnesic aphasia which led us to suppose that a cerebral abscess was present. The operation brought to light a large extradural and a small subdural abscess. The aphasia was accounted for by the presence of serous encephalitis in the left temporal lobe. This patient recovered.

The third patient, who had a subdural abscess in the posterior fossa, also made a good recovery. The symptoms were mainly those of the serous meningitis, which had resulted from the presence of the pus.

It is, unfortunately, impossible to diagnose a subdural suppuration with certainty. The condition causes no characteristic symptoms, but only presents the picture of a severe cerebral complication, differing in this point from extradural abscess, which usually gives rise to no marked subjective trouble, and is only discovered at the time of the operation.

In the first and third cases described above the picture was that

of meningitis ; in fact, in Case III. it was actually serous meningitis which caused the severe symptoms. In Case I. the cerebro-spinal fluid was not increased in amount ; the lateral ventricles contained about half a teaspoonful. In Case II. the picture was rather that of cerebral abscess. The cases described in the literature resemble ours in that they present the same uncertain signs.

The lessons learnt from Case I. may, perhaps, be of use in the future for the purpose of forming a diagnosis by exclusion. If I meet a similar case again I shall certainly act differently. Some of the symptoms pointed strongly to meningitis, but the results of the repeated lumbar puncture did not confirm this diagnosis. The cerebro-spinal fluid was not increased in quantity, nor did it contain pus or bacteria. Careful probing had failed to disclose a cerebellar abscess, though this, of course, was not absolute proof that one was not present. In such a case it would, perhaps, be better to expose the temporal lobe and incise the dura freely, even though there was no sign of disease of this region ; but even then one could not be absolutely certain of finding the subdural abscess. This is proved by Hölscher's case, in which the pus was underneath the frontal lobe and therefore could not be reached from an opening through the squamoid portion of the temporal bone.

THE OPERATION.

The objects of the operation are to remove diseased bone and to expose the dura as freely as possible where it appears to be infected. The membrane must be exposed beyond the limits of the bone disease, but it need not be farther uncovered when once a part is reached where it looks normal or nearly normal underneath the granulations. The granulations themselves should be gently removed with gauze swabs, not scraped away with a curette.

Even when the dura is infiltrated with pus and a greenish colour suggests gangrene, I do not think that portions of it should be excised, although, according to ordinary surgical principles, this course would seem to be indicated. It has become adherent to the arachnoid and there is danger that any active interference may destroy this natural protection and expose the subarachnoid space to infection. It is better to wait and allow the dead parts to separate spontaneously. The removal of the diseased portion is only permissible when the dura has been raised by subdural sup-

suppuration from the arachnoid, and even then only when the wound is large enough to make its deeper recesses easily accessible.

In Case III. mentioned above, for instance, this was not possible, as the diseased dura mater extended so far towards the middle line that sufficient bone could not be removed to make it accessible, without injury to the posterior semicircular canal and the internal auditory meatus.

If there is a very extensive extradural abscess affecting both the middle and posterior fossæ, the bone must only be removed in as far as it is diseased. In a case reported by Körner this involved the loss of a large amount of tissue; the opening in the cranial wall extended from the mastoid to within $1\frac{1}{2}$ centimetres of the middle line of the occiput and was from 4 to 6 centimetres in width. It was protected later by a plate of Stentsch's material. In my case (*vide supra*) we were able to retain a large part of the bone, but the dura had become so inflexible from the long-continued suppuration that it was incapable of being applied to the bone. In such cases the best method is to form a flap consisting of skin, periosteum and bone, fix it over the gap, and allow it to become attached.

Extradural abscesses at the apex of the petrous pyramid are best opened by the method suggested by von Bergmann for the evacuation of abscesses in the temporal lobe (see pp. 179 and 180).

Streit* has suggested another operation, but as yet has only performed it on the cadaver.

If the subdural suppuration is extensive, it is advisable to insert a drainage wick of gauze carefully under the dura; mere opening of the space is not sufficient, and drainage is essential for some time.

* *Archiv für Ohrenheilkunde*, Bd. lvii.

Stentsch

CHAPTER II

OPERATIVE TREATMENT OF AFFECTIONS OF THE INTRACRANIAL BLOODVESSELS*

1. PHLEBITIS AND THROMBOSIS OF THE LATERAL SINUS AND JUGULAR VEIN :
Diagnosis of sinus thrombosis—Perisinous abscess and benign thrombosis
(compression thrombosis)—Septic thrombus blocking the lumen of the
sinus—Parietal thrombosis—Thrombosis in the jugular bulb—Ligature
of the jugular vein. 2. THROMBOSIS OF THE CAVERNOUS AND PETROSAL
SINUSES.

1. PHLEBITIS AND THROMBOSIS OF THE LATERAL SINUS AND JUGULAR VEIN.

Diagnosis of Sinus Thrombosis.

PYÆMIA is the most frequent of all the dangerous complications of acute and chronic middle-ear disease. In Lucae's clinic, from 1881 to April 1, 1903, there were 118 cases of pyæmia—77 of uncomplicated meningitis and 51 of cerebral abscess. The statistics of Körner, Pitt, Gruber and Paulsen† yield similar figures.

Pyæmia following suppurative otitis media may be occasionally set up in some other way than as a result of thrombosis of the lateral sinus or the petrosal sinus, but this is so rare an occurrence that we need not, and ought not, to take it into consideration.

Körner has suggested that the infective material may reach the general circulation by means of thrombi formed in the small veins of the bone which open into the sinus and into the veins of the

* Part of this chapter is taken from my paper on the 'Operative Treatment of Sinus Thrombosis of Aural Origin,' published in the *Archiv für Klinische Chirurgie*, Bd. lxx., H. 3.

† 'Die Otitischen Erkrankungen des Hirns,' 3 Aufl., 1903, S. 3.

dura. The researches of Leutert* and others have, however, negatived this idea.

Brieger has shown that it is always possible for the bacteria to spread from the original focus of disease—*e.g.*, from the acutely inflamed tympanic mucous membrane—by making their way into the veins and capillaries around. In this way he explains two cases in which pyæmic fever occurred (in one with abscesses of the lung, in the other with metastases in both knee-joints), although the autopsy showed perfectly normal bloodvessels without a sign of thrombosis. Schwabach has reported a similar case. I therefore do not think it is correct to hold, as some do, that pyæmia invariably results from sinus thrombosis. I have seen several cases of a more or less pyæmic type in which the sinus was found on operation to be normal in appearance. These cases, however, do not provide absolute proof, for the patients recovered, and there may possibly have been a small thrombus on the wall of the vessel, which underwent spontaneous resolution.

A differential diagnosis between pyæmia with and pyæmia without sinus thrombosis is at present impossible, but the latter condition is certainly exceedingly rare. We must therefore act in doubtful cases on the assumption that the sinus is diseased.

The diagnosis 'thrombosis of the lateral sinus' must therefore be made if, in the course of middle-ear suppuration, pyæmic fever with rigors appears, and distinct metastases form in the lungs, joints, muscles or bursæ.

Griesinger's Sign—namely, localized painful œdema at the posterior edge of the mastoid—is, according to Körner,† unreliable. It may arise from disease of the bone and is very common in connection with extradural abscess in the posterior fossa. Similarly, the unequal filling of the external jugular vein, which Gerhardt has described as occurring in children with marasmic sinus thrombosis of aural origin, has been shown by Körner to be only occasionally demonstrable owing to local conditions. My own experience confirms Körner's opinion: I attach no importance to Griesinger's sign, and I have never seen a case in which Gerhardt's could be demonstrated.

If the thrombosis extends into the jugular vein, the vessel may sometimes be felt as a cord-like mass under the skin. I believe, however, that this is only the case when the wall of the vessel is

* *Archiv für Ohrenheilkunde*, Bd. xli.

† 'Otitische Erkrankungen,' 4 Aufl., S. 106.

thickened by phlebitis and periphlebitis, and the glands surrounding it are infiltrated. I have never succeeded in feeling the vein through the soft parts when its lumen was merely blocked by masses of thrombus. On the other hand, I have on several occasions, when seeking for the cord-like swelling, imagined that I could feel it, although the subsequent course of the case proved conclusively that there could not possibly have been a thrombosis of the jugular. For this reason, I think that the surgeon should be on his guard against believing too readily that this sign is present.

The diagnosis is exceedingly difficult, or even impossible, if the signs of generalized pyæmia are absent. These are, however, the very cases in which rapid action is called for in order to check the disease in its early stage. All hesitation and waiting for definite signs to confirm the diagnosis expose the patient to the gravest danger. On one day there may be no more than a perisinous abscess and on the next the inflammation of the vessel wall may have already set up thrombosis.

Perisinous Abscess and Benign Thrombosis (Compression Thrombosis).

When the mastoid is opened up a collection of pus is often found around the sinus, especially in cases of acute suppurative otitis media. The bone is destroyed to a greater or less extent and the sinus is exposed. Its walls are generally thickened, greyish-red in colour and covered with granulations which, as a rule, can be easily detached. A perisinous abscess does not usually give rise to symptoms allowing of its being diagnosed before the operation.

It is certain that such a collection of pus may be present for a long time round the sinus without causing thrombosis. The newly-formed granulations and the thickening of the vessel wall form a protection against the advance of the bacteria. In these cases there is no indication for interference with the sinus ; recovery takes place without it.

It is more difficult to decide on the right course of action when the conditions around the sinus are the same as those just described, but other symptoms point to more extensive disease of the vessel itself.

In the course (not in the beginning) of an acute or chronic middle-ear suppuration, which perhaps up to then has caused no severe

subjective symptoms, the patient suddenly develops a temperature of 102° F. or more, accompanied by one or more rigors. Added to this are headache and general malaise and the appearance of the patient becomes rapidly worse. The fever alone is enough to cause alarm; it points to the presence of some grave complication, for acute middle-ear disease and acute exacerbations of chronic otitis only cause, as a rule, a slight rise of temperature, and that in the earlier stages. The necrosis may have extended widely in the mastoid and the abscess may be quite large, but as long as the sinus is not affected there will be no fever except in the rare and negligible cases of septicæmia (Brieger) and sapræmia (Eulenstein). Only when the inflammation spreads to the periosteum, and from there causes a more or less extensive infiltration of the soft parts, does a rise of temperature (generally not above 102° F.) take place.

Children are an exception to this rule. Even in the beginning of an acute attack of otitis media a child's temperature may rise much higher than that of an adult under the same circumstances; temperatures of 104° F. and higher have not infrequently been observed. After perforation of the drum, especially if it has not occurred spontaneously, a child's temperature may remain up for days. It is well to bear in mind that in some cases pyrexia continues for a week or a fortnight, although there are no complications whatever. In children, therefore, high fever alone, without any other symptoms, in the early stages of acute otitis media is not an indication for opening up the mastoid, much less for an operation on the sinus.

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In the course of a chronic suppurative otitis media, and in the later stages of an acute attack, the surgeon must be careful to remember and exclude other possible causes of the fever before deciding to operate. I have often seen intercurrent attacks of influenza, tonsillitis, bronchitis, or even digestive disturbances, causing a rise in temperature.

In some cases it is quite impossible to discover the true cause of the fever at the first examination, though one may have good reason to believe that it is not due to the otitis media or a complication thereof. Leutert and I have each seen one case in which erysipelas manifested itself only after the patient had had fever for a week. The following case is also a good example:

A young man was admitted supposed to be suffering from sinus thrombosis. In view of the symptoms and signs, I could not agree with this diagnosis, although he undoubtedly had acute otitis media.

A careful general examination failed to reveal any reason for the fever, but nevertheless I refused to operate. A few days later typical rose-spots appeared and there was no doubt that the patient had typhoid.

When every cause for the fever has been excluded except the suppurative otitis media, the surgeon must endeavour to determine the exact nature of the intracranial complication. He must consider if meningitis is present, or if he has to deal with the initial stages of a cerebral abscess. These affections are discussed in their proper sections. If they are both out of the question, we may assume that sinus thrombosis is present.

Some cases will always remain in which an accurate differential diagnosis is not possible, but nevertheless the surgeon should not hesitate to operate as soon as it has been proved that the pyrexia is of aural origin. On this point I differ from Leutert, who holds that the operation should be postponed for a few days to see if the fever will continue.

To sum up, my view is as follows :

If, in the course of a case of suppurative otitis media, the temperature suddenly rises, while it is possible to exclude specific fevers with fair certainty, and there are no symptoms of meningitis or cerebral abscess, the sinus should be exposed without delay.

I am not in favour of laying down hard-and-fast rules, but believe that every case should be considered on its merits. Some guiding line must, however, be followed, otherwise the surgeon will be unable to come to any definite decision.

Before dealing with the sinus I open up the mastoid and expose the antrum in acute cases, and in chronic cases complete the whole radical operation. In the great majority of cases which present sinus symptoms a perisinous abscess is found, so that when the cavity in the mastoid is opened it is often seen to be partially bounded by the sinus on the median side and posteriorly. The wall of the sinus is thickened and grey-red in colour and is covered with soft, loosely attached granulations ; it is roughened and sometimes has stringy, fibrous masses attached to it. If the vessel is full of blood, the wall is bulged out and feels tense and elastic to the finger. Pulsation is usually present, but its absence is not evidence of thrombosis. On the other hand, pulsating movements may be transmitted to a thrombosed sinus from the arteries in the hyperæmic

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cerebellar dura. Thus, the presence or absence of pulsation in the sinus is an uncertain sign and its importance must not be exaggerated.

When the sinus is tense and elastic it is best to adopt an expectant attitude. The fever can only have arisen because the wall of the vessel has become permeable for the bacteria and their products; but the temperature often falls immediately after the operation on the mastoid—that is, as soon as the focus of suppuration round the vessel has been eliminated.

In another type of case, however, it is less easy to decide whether to postpone active measures or not. In these patients the sinus shows the following picture: When the cavity has been cleared of pus and granulations, the wall of the sinus is found to be sunk in. If the vessel has been exposed sufficiently freely upwards and downwards, a sharp line of demarcation can be seen between the diseased portion and the healthy, elastic, bluish part of the wall. The diseased tissue has an eroded appearance, and it is easy to see that the suppurative process has caused a certain amount of ulceration.

But what of the interior of the sinus? Has a thrombus already formed? I think Jansen* is right in saying that there are such things as benign thrombi arising solely from pressure on the vessel wall by a perisinous abscess. Stenger,† too, from his own experiments and those of Talke and Köster, concludes that the infection of the thrombus is secondary, and that at first it is sterile. According to Leutert,‡ on the other hand, the researches of Eberth and Schimmelbusch prove that all thrombi are infected with septic material and they should therefore be removed, whether fever is present or not. But many cases of undoubted thrombosis end in spontaneous recovery and it is difficult to realize how this can occur if all sinus thrombi are septic.

I must admit that, with the signs and symptoms described above, it is often impossible to be certain that thrombosis has occurred. I have several times punctured the sinus, and found it to contain blood, although severe general symptoms pointed to the presence of an infected thrombus. This test, however, only shows that the whole lumen of the vessel is not blocked by a clot; it does not disprove the presence of a parietal thrombus. In two cases I incised

* 'Verhandlungen der Deutschen Otologischen Gesellschaft,' 1901, S. 14.

† *Ibid.*, 1904, S. 109 *et seq.*

‡ *Ibid.*, 1901, S. 112.

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the sinus, but found it empty. In the post-mortem examination on a case of cerebellar abscess we found the sinus wall so much thickened that the lumen would only allow a fine probe to pass through. I think, therefore, that the sinus may be narrowed to the extent of being completely closed from compression and thickening of the wall alone. Closure by thrombosis then follows above and below the affected part of the wall. Whether a thrombus is present or not, I believe, with Jansen, that it is a mistake to open up the sinus in these cases. Even tapping with a Pravaz' syringe is not advisable. In rare cases the temperature remains high during the first few days after the operation on the mastoid, or a rigor may even occur. Under these circumstances, of course, the sinus operation is indicated.

If no perisinous abscess is present, and the sinus is not exposed by disease in the bone, the pyrexia can only be referred to disease inside the vessel and it is, therefore, necessary to lay bare the sinus and open it up. In some cases a band of granulations leads to the sinus; in others, especially when cholesteatoma is present, the bone shows a greenish discoloration at one point; in others, again, even microscopic examination reveals no alteration in the bone. In cases of the last type the bone should be removed with the chisel in flat shavings, always from behind forwards, until the vessel wall is reached. The chisel or bone forceps is now used until enough of the vessel is exposed to allow of an opinion being formed as to its condition. In this connection I may remark that I do not consider exposure of the sinus an altogether safe operation, as Leutert does. In my opinion the cases published by Grunert, Zeroni and Pause, prove clearly that the operation is not unattended with danger. The cases of Körner,* Hansberg,† and Freytag‡ also point to this conclusion. Quite apart from the fact that we have to deal with a more or less infected field, septic material may reach the wound from outside and can never be excluded with absolute certainty, especially in a hospital where a large number of cases are dealt with. Infection may occur secondarily, by the patient, in spite of the strictest injunctions, introducing his finger under the dressings in order to scratch himself or to loosen the bandages. If the wound once becomes septic, there is nothing to prevent involvement of the sinus wall and the formation of a septic thrombus.

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* *Z. f. O.*, Bd. xl., S. 116.

† *Ibid.*, Bd. xlv., S. 288.

‡ *Ibid.*, Bd. xlv., S. 131.

I believe, therefore, that exposure of the sinus should be avoided in general and only undertaken in the cases which I have described. When it is done it should be done thoroughly.

In most cases the portion of the sinus diseased is the descending part between the upper and lower bend. Sometimes, however, this part is healthy, and the extension of inflammation from the bone is found to have occurred at a point between the lower bend and the bulb of the jugular vein. This must be borne in mind if the portion of the sinus first exposed appears healthy.

Septic Thrombus blocking the Lumen of the Sinus.

External examination of the sinus wall is often sufficient to make a diagnosis of occlusion of its lumen. The vessel, instead of being normally tense and elastic, feels hard and sausage-like. The lateral wall is resistant, and can only be pressed in with difficulty. The vessel may present similar appearances to those described in the last section: the lateral wall may be covered with granulations, softened, infiltrated with pus and thickened. In chronic suppuration, and when cholesteatoma is present, the wall is sometimes of a dirty grey-green colour, and but very slightly thickened, or not at all. It may show a fistulous perforation or be destroyed to a considerable extent, while pus and ichorous fluid, the products of decomposition in the thrombus, exude from the opening.

But it is not always possible to decide at once whether the sinus is thrombosed or not from external examination alone. In these cases (unlike those described in the previous section) it may be imperative to come to a definite conclusion, owing to the grave general condition, and perhaps repeated rigors, which point strongly to the diagnosis of sinus thrombosis. Under these circumstances the proper procedure is to puncture the vessel.

When the sinus has been exposed backwards and downwards until healthy tissue is reached (if necessary, as far as the torcular and the bulb of the jugular vein), a sterilized Pravaz' needle is inserted cautiously into the vessel in a direction almost parallel to its wall. If the cannula enters the vessel in a direction at all approaching the perpendicular, it may easily pass through the median wall and injure the cerebellum. On the other hand, it must not be kept too close to the wall, for this may be thickened and the needle may not

reach the lumen. Occasionally it is necessary to make a second puncture before one can be sure that the needle is in proper position. If there is only a parietal thrombus, the results of puncture are very liable to be misleading. In such a case the presence or absence of blood in the syringe depends on the depth to which the needle is inserted, and does not give any information as to the presence or absence of a clot.

I willingly admit these sources of error, but I cannot agree with Leutert and others, who believe that puncture of the sinus should therefore be abandoned altogether in favour of incision. Puncture, in most cases, gives sufficient information as to the contents of the sinus and is not dangerous—or, at least, is far less dangerous than incision. *puncture incision*

Theoretically we can never exclude the possibility of carrying on the needle some of the pus from the exterior to the interior of the sinus. To prevent this Zaufal recommends irrigating the wound with sublimate solution, but this method is not effective. In practice I have never seen any bad results from puncture. Even if the sinus is free from clot, hæmorrhage does not occur to any extent from the small perforation.

On the other hand, if an incision is made and no clot is found, the wound must be firmly packed and the gauze left in position for several days. Under these circumstances, the conditions necessary for the formation of a thrombus (as laid down by Leutert from the results of the experiments of Eberth and Schimmelbusch) may be present—namely, disturbance of the circulation and prolonged bacterial action on the wall of the vein. In most cases the vessel wall is already diseased and the tight packing will favour the spread of inflammation. Even if it were healthy we cannot exclude the possibility of secondary infection, and if we have to deal with a chronic fetid middle-ear suppuration or with an extensive cholesteatoma, the gauze will soon be soaked with the secretions. After accidental injury to the sinus I have several times found its wall softened and infiltrated and the packing material sodden with pus. *evidently for direct to wound.*

Several cases of sinus thrombosis following trauma have been published by Grunert and Zeroni,* Müller and Török,† and others. These are not, however, admitted to be conclusive by those who believe that incision is free from danger. In my paper already

* *A. f. O.*, Bd. xlix., S. 11 (Jost).

† *Ibid.*, Bd. l., S. 65.

quoted,* I published a case from our clinic which seems to me quite sufficient to prove the point.

Thus I believe that incision of the sinus wall, like an accidental wound, is and remains dangerous. Nevertheless, I by no means reject exploratory incision altogether. I agree with Brieger that incision should be employed to give further information when the knowledge gained from puncture alone is insufficient.

Jugular It is now generally agreed that when a thrombus blocking the lumen of the sinus has been definitely diagnosed it must be removed—supposing always that we are dealing with a case of pyæmia in which the thrombus must necessarily be infected. Opinions still differ as to whether the jugular should be tied in every case, and whether this manoeuvre should be carried out before or after the sinus is cleared of the thrombus. I will not enter into this matter here, but will reserve the discussion of so important a question for another chapter. I may, however, mention briefly that I believe the jugular should only be tied in some cases, not in all, and therefore the usual procedure will be to clear out the sinus at once.

noth thrombus move- The wall should be split, a grooved director pushed forwards cautiously and the incision prolonged in both directions until the ends of the thrombus are approximately reached. The lateral wall should then be grasped in a toothed forceps, and enough of it removed with scissors or a scalpel to allow of a good view of the contents being obtained. The thrombus—or at least as much of it as appears to be broken down—must then be extracted with a curette. Whether the firm ends of the clot should be removed until free hæmorrhage shows that the lumen of the vessel is clear is still undecided; different authorities hold different opinions on this point. Jansen thinks that the removal of masses of fresh red thrombus is not wrong, although he does not recommend it for every case; while Brieger considers it not only useless, but even possibly dangerous. According to the latter, one cannot be certain of removing the whole of the clot and, moreover, the subsequent packing may lead to the formation of fresh thrombus, which is exposed to infection by the micro-organisms in the wound. On the other hand, even a thin layer of healthy thrombus may prevent the formation of metastases, as Kümmel's† case proves. Von Berg-

* *Loc. cit.*, S. 614.

† *Z. f. O.*, Bd. xxxi.

mann,* too, recommends that only the softened masses should be extracted. If pus or a semi-solid purulent mass is found in the sinus, the lumen should be left shut off above and below by fresh clot.

Whiting† and others are in favour of scraping away all thrombus masses until the circulation is restored. They are of opinion that by this means the retention in the wound of apparently healthy, but really infected, portions of the clot can best be avoided. *Whiting removes all clot.*

According to my experience, no definite rules can be laid down ; the appearances in each case must determine the course of action. I believe that, just as there is no reason for the removal of benign thrombus causing no symptoms, so it is unnecessary and dangerous to break down the protective wall of healthy clot which Nature has formed in the vessel. The danger of secondary suppuration in the exposed remains of the clot is not so great as would at first sight appear. The sinus is freely opened, and a loose gauze packing soaks up the secretions rapidly. Retention of secretion is further prevented by frequent dressing of the wound, which can be done as often as is necessary, since there is no fear of hæmorrhage. I have seen several cases in which it was impossible to reach the lower pole of the thrombus owing to its extending into the bulb of the jugular vein. Under these circumstances pus collected in the cardiac end of the sinus, but the pyæmic symptoms ceased. Daily dressing of the wound and careful swabbing away of the pus caused the secretion to dry up gradually and eventually the lumen of the sinus was closed by healthy granulations.

Speaking generally, healthy clot is dark red or brown red in colour ; if it begins to break down it becomes grey, blackish, dirty green or yellow, and at the same time, instead of being firm and elastic, it becomes soft and friable. Nevertheless, it is not always easy, and sometimes quite impossible, to decide whether the thrombus is benign or not. The appearances may be deceptive : a healthy-looking surface does not exclude the presence of foci of suppuration in the interior. Not long ago I removed a long, firm clot externally healthy-looking, but containing enormous numbers of streptococci inside. If any doubt remains, or there is any reason from the appearances and general symptoms to suspect that the thrombus is septic, it must be followed up and removed until free *Can not tell from appearance infected at throm*

* 'Die Chirurgische Behandlung der Hirnkrankheiten.'

† Z. f. O., Bd. xxxv.

hæmorrhage sets it. The danger of small emboli getting into the blood-stream is not so great as at first sight appears. The strong rush of blood sweeps the small particles outwards. The surgeon may safely allow the bleeding to continue for a few seconds in order to ensure that all the loose portions of the clot are driven out. There is, of course, some danger in allowing the vessel to bleed freely, but it is not as great as the danger of leaving pieces of septic thrombus behind, and in such cases we must naturally try to choose the lesser of two evils. On the other hand, it is not always possible to bring the process of thrombus formation to an end by removing the whole of the clot. In bad cases the disease of the vessel wall will continue to make progress, and a new septic thrombus may be formed. On one day the wall may seem perfectly healthy and the sinus may be filled with blood, while on the next the lumen may contain decomposed masses of clot and the intima show a greyish-green colour. The packing of the wound is certainly a determining factor in this unfavourable course of events, but the principal cause is the severity of the primary infection.

It is always possible to clear out the posterior part of the sinus; there is nothing to prevent its being exposed as far back as the torcular Herophili. In the downward direction we cannot go beyond the bulb of the jugular. I shall discuss later under what circumstances and how the bulb itself should be surgically treated and, further, to what extent ligation of the jugular vein prevents embolism and extension of disease in the vessel wall.

I must mention here another unpleasant accident—namely, the entrance of air into the veins through the sinus. Schwartze first, and later Jansen, Körner and Meier, called attention to the indrawing of the wall of the vessel, which recurs with each inspiration. This is determined by the suction-force of inspiration, which causes the blood to flow more rapidly to the heart and may set up a negative pressure in and a temporary emptying of the sinus. This, however, is not the real main cause, and in the same way acts of deglutition (Piffel) and an erect position of the patient (Meier) can only be looked on as adjuvatory factors, since the walls of the vessel have been observed to come together when none of these conditions were present.

Körner* assumes that in one of his cases the sinus was blocked at the cerebral end and open towards the heart. I, too, believe

* *Z. f. O.*, Bd. xxx., S. 231.

that a mechanical obstruction to the flow is necessary to produce this phenomena ; otherwise we should see it much more frequently. Although I have exposed many sinuses, I have observed this collapse of the wall in very few. I saw it occur in two cases, one soon after the other : first in an elderly man under anæsthesia, the breathing being regular ; and, secondly, in a child during the dressing of the wound, the patient being in a sitting position. In neither case was there any clinical sign of thrombus narrowing or blocking the lumen.

It is possible that certain anatomical relations provide the true cause. In the above-mentioned case published by Körner and Meier, as in both of mine, the left sinus was the one affected. It is possible that in these cases, as often happens, most of the blood from the superior longitudinal sinus passed into the right lateral sinus, and that only a very narrow communication existed between the lateral sinuses of the right and left sides. I have observed this disposition of the parts once in an autopsy. Under these circumstances it is conceivable that the amount of blood flowing from the straight sinus into the left lateral sinus is not sufficient in quantity to fill the lumen of the larger vessel. From this would result a temporary lack of blood in the lateral sinus, until the deficiency was made up by a flow from the superior longitudinal sinus.

This explanation is, of course, no more than theoretical. Supposing, however, that all the communications between the vessels were fully patent, it is difficult to see how a part of the lateral sinus could be, even for a moment, so emptied of blood that the external atmospheric pressure would cause its wall to collapse. Blood flows more quickly through a vein in proportion as the pressure at the cardiac end diminishes. If, therefore, the anastomosis is free and the circulation is not arrested at any point, the vessel must always remain uniformly filled, or at most will show scarcely visible respiratory changes in tension.

The experiments of Senn, quoted by Schenke,* seem to support my view. Senn concludes from experiments on animals that a fatal air embolus from the jugular vein is an impossibility, because the walls of this vessel lie in contact during inspiration. The spot at which the flow of blood is retarded is in this case the bulb, a fact which has also been observed by Meier.† The anatomical structure of the bulb of the jugular varies very much in different cases ; it

* *A. f. O.*, Bd. liii., S. 182.

† *Ibid.*, Bd. xlix., S. 241.

may be flattened or reach high up into the petrous bone. In one dissection the sinus may pass imperceptibly into the bulb, while in another the bend is so sharp that the projecting ridge of bone forms a barrier between them. According as the conditions in the bulb are unfavourable to a rapid and regular flow of blood when a negative pressure is produced in the jugular vein, the walls of this vessel will be liable to come together during inspiration. Complete contact of the walls of the sinus, such as Senn supposes to occur in the jugular, is not possible, since the median wall is but slightly movable. A space for the entrance of air will therefore always remain.

Up to the present only one fatal case of air embolus from the sinus has been reported.* Meier,† while dressing a wound, observed air entering the sinus. Schenke‡ and Brieger§ have also seen this accident occur, the latter while the patient was sitting upright and immediately after a large necrotic piece had been removed from the outer wall of the vessel.

Hence the surgeon should always proceed with great caution in opening a sinus in which the blood still circulates, or in removing the last remains of clot. The patient must be lying flat and breathing quietly; narcosis must be fairly deep. Further, it may be well, following Meier's suggestion, to isolate the portion of the sinus to be opened by pads pressed on it above and below or pushed in between the bone and the vessel wall. If this is impossible below owing to the proximity to the bulb, the surgeon may try compression of the corresponding jugular vein in order to close the path to the heart. If this manœuvre does not succeed, the vein may be tied as Körner suggested.

As soon as the sinus has been opened and its septic contents removed, we may in ordinary cases bring the operation to an end and await results.

Parietal Thrombosis.

Parietal thrombosis and thrombosis in the bulb of the jugular (to be described in the next section) have only been recognized and properly understood during recent years. According to Leutert, many cases formerly considered to be pyæmia without sinus throm-

* Kuhn, *A. f. O.*, Bd. xxx.

† *A. f. O.*, Bd. xlix., S. 241.

‡ *Ibid.*, Bd. liii., S. 148.

§ 'Verhandlungen der Deutschen Otologischen Gesellschaft,' 1901, S. 85.

bosis, must now be regarded as examples of parietal thrombosis. The clot, which is often very small, might easily be overlooked during the autopsy, and it is thus easy to understand that a diagnosis in the living patient is often extremely difficult. In some cases a diagnosis can only be arrived at by exclusion, and in others it may be impossible to come to a definite opinion.

The presence of a parietal thrombus can be most easily determined, or perhaps I should say suspected, when the sinus is laid bare by the disease in the bone. I have never, it is true, succeeded in diagnosing this condition by palpation in the manner Whiting* has described.* A condition of the vessel allowing the edge of a parietal thrombus to be differentiated with the finger from the neighbouring healthy sinus wall must be exceedingly rare. The wall is, as a rule, infiltrated and thickened over an area corresponding to the extent of the bone disease, and it will therefore be scarcely possible to recognize differences of resistance in different parts by palpation. We can only conclude that a parietal thrombus is present from the general symptoms of pyæmia, combined with the knowledge (gained from puncture or incision) that the vessel contains blood. Even after puncture which yields blood it is still possible that the whole lumen is filled with clot, except the part close to the wall. If the sinus be incised, the severe hæmorrhage will make it quite impossible to determine the situation and extent of the thrombus or to effect its removal.

On this account Whiting† and Meier,‡ independently of each other, suggested emptying that portion of the sinus of its blood and then incising the wall. The sinus is first exposed and is closed at the cardiac end by inserting a pad of gauze between it and the bone. The blood is then gently forced upwards out of the small stretch of sinus and the upper end is closed in the same way. The wall of the vessel may now be incised and the interior examined. Hölscher§ describes a similar method. Brieger|| has pointed out that Meier's method can only give a good result when we are dealing with the sigmoid portion of the sinus. At this point the flow of blood into the sinus from tributaries entering its median wall is but slight, whereas at the bend of the vessel the junction with the superior petrosal sinus renders complete emptying difficult.

* *Z. f. O.*, Bd. xxxv., S. 100.

† *Loc. cit.*, SS. 200, 209.

‡ *A. f. O.*, Bd. xlix., S. 240.

§ *Ibid.*, Bd. lii., S. 123.

|| 'Verhandlungen der Deutschen Otologischen Gesellschaft,' 1901, S. 98.

The manipulations for pressing the blood out of the sinus are not altogether free from danger. We cannot exclude the possibility of particles of the clot becoming detached and being swept away into the general circulation. Another source of danger lies in the temptation a surgeon feels to empty and open the sinus almost in every case in order to examine the interior more easily. This undoubtedly may set up thrombosis where none existed before.

Since it is difficult to find and attack the thrombus at its point of origin, attempts have been made to nullify its deleterious action by other means. Of these methods the best seems to be ligation of the jugular vein. Brieger, however, points out that by doing so a parietal thrombus is converted into one of the dangerous kind, blocking the lumen of the vessel. The column of blood above the ligature clots, as many pathologists have observed post-mortem, and if bacteria invade the thrombus they find a favourable medium for their development. Brieger, therefore, does not agree with Leutert that the jugular should be tied in every case of parietal thrombus when severe pyæmia is present, especially as in his experience these cases often end in recovery without operative interference.

I think Brieger is right in believing that the natural bactericidal action of the blood is capable of rendering a parietal thrombus innocuous if no fresh supply of micro-organisms reaches it from outside. This view is supported by the cases described at the beginning of this chapter, some of which at least were probably cases of parietal thrombosis, although this could not be definitely proved.

In one case which ended in recovery we were obliged to conclude that a parietal thrombus was present. The sinus appeared outwardly healthy when it was exposed, but for some twenty-five days afterwards slight intermittent fever was present, and once there was a rigor. Further, painful swellings of the left shoulder and the left elbow-joint appeared for a short time.

In two cases I have seen a parietal thrombus develop into one blocking the whole sinus; in both opening and clearing out of the vessel brought about recovery. We must be prepared for this change in the character of the thrombosis, but it is so rare that the risk of it is less than the risk involved in ligating the jugular vein and opening the sinus in all the cases where there is reason to suspect the presence of a parietal clot. The first operation does not render the second more safe; on the contrary, after the jugular vein

has been tied, the free hæmorrhage from the petrosal sinus makes it necessary to plug that part of the wound, and in doing so the surgeon shuts off a column of blood which clots and is very liable to undergo decomposition.

Thrombosis in the Jugular Bulb.

Difficult as it is to determine the position of a parietal thrombus in the lateral sinus, it is still more so—in fact it may be impossible—to locate disease in the wall of the jugular bulb. This holds good whether the affection arises primarily by extension of inflammation from the floor of the tympanic cavity, or secondarily, as Leutert supposes, through micro-organisms being washed down in the bloodstream from higher parts of the sinus. We can only suspect the presence of a parietal thrombus in the bulb when disease of the lateral sinus has been excluded. The test devised by Whiting for determining the presence of thrombosis in the bulb is not conclusive, unless the whole lumen is blocked. Whiting first empties the sinus of blood by the method already described. The pressure at the cardiac end is then removed, and the vessel remains empty if the bulb is completely blocked. It is clear, however, that a parietal thrombus will scarcely influence the back-flow of the blood.

In the treatment of parietal thrombosis in the bulb, the question of ligation of the jugular vein has to be considered first. The arguments against tying the vessel in thrombosis of the lateral sinus apply with even more force to the cases now under discussion. In the lateral sinus it is possible in many cases to attack and remove the cause of infection, but in the bulb the most that can be done is to shut it off from the general circulation. But what then becomes of the septic thrombus? Does it suddenly cease to be infective and lose its tendency to decompose? This would be very hard to prove and seems unlikely, since by ligature of the vein the clot is withdrawn from the bactericidal action of the circulating blood.

I believe that we should be very cautious in judging the value of ligature in doubtful cases, where the presence of a thrombus has not been conclusively demonstrated. A case which I saw some time ago may serve as an example. A child six years old had suffered for four weeks from acute suppurative otitis media. Owing to intermittent fever, the temperature rising as high as 104·2° F., accompanied

by a rigor, the mastoid was opened and the sinus exposed. The mucous membrane of the cells was swollen, no pus was found, and the sinus appeared normal. The pyrexia lasted two days longer: the temperature went as high as 104·8° F., and then fell to normal, the patient breaking out into profuse perspiration during the crisis. In spite of the most careful general examination, no other cause for the fever than the acute middle-ear disease was to be found.

Judging from some of the reported cases, some surgeons would have tied the jugular vein and incised the sinus in this case. Having found nothing there, they would have made a diagnosis of thrombosis in the bulb.

A primary thrombus blocking the lumen of the bulb may be recognized by the method of Whiting described above. Mann* suggested another method, which, according to him, causes no extra danger to the patient beyond that involved in laying bare the sinus. He turns the patient's head towards the sound side until the affected mastoid is vertically over the sterno-clavicular joint. If there is no thrombus blocking the lumen pulsation can be observed in the sinus, provided that the vessel has been exposed to a sufficient extent.

The blocking of the bulb may occur secondarily through spreading of the disease of the vessel wall and of the thrombosis from the sinus. The presence of the bulb thrombus may then be diagnosed from the fact that the end of the clot cannot be reached in the ordinary way. When the sinus has been opened up, the clot is found to be discoloured and greasy-looking, and the wall of the vessel is diseased right down to a point close to the bulb. Formerly surgeons were content to tie the jugular vein in these cases. In one patient whom I treated thus the pus made its way to the surface a considerable time after the ligature had been applied, and it was only then that the intermittent fever and rigors ceased, no metastases having formed. The course of events was not, however, so favourable in most of the cases treated in this way.

Even after ligation of the jugular metastatic deposits may occur from the thrombus left behind in the bulb. Slitting up the vein to the base of the skull or irrigation of the bulb cannot prevent this accident, and irrigation, moreover, has the great disadvantage that if the pressure is too great the cerebellar dura may be torn and a purulent meningitis set up. On account of experiences of this kind

* *Z. f. O.*, Bd. xl., H. 4, and 'Verhandlungen der Deutschen Otologischen Gesellschaft,' 1904, S. 121.

Grunert* tried attacking and exposing the bulb itself. The jugular is first tied, the apex of the mastoid process removed, and the sinus exposed almost as far as the bulb. A way is then made along the base of the skull with a blunt instrument as far as the jugular foramen, and the piece of bone bounding the opening laterally is removed with a Lüer's forceps. Care must be taken not to injure the facial nerve or the vertebral artery. When the bulb has been exposed it is opened and the incision prolonged towards the jugular vein and towards the sinus, so that finally we have an open groove formed by all three parts of the venous channel. A similar method, but without necessarily ligating the jugular vein, has been described by Stenger,† from the otological clinic of the Berlin Charité Hospital.

Piffi‡ recommends making the bulb accessible by removing the inferior and anterior wall of the external auditory meatus and the floor of the tympanic cavity. O. Voss§ has worked out a method which can be carried out without difficulty in most cases. It is based on the fact that, as a rule, the bulb is not situated underneath the floor of the tympanum, but posterior to it and nearer to the middle line of the body. The lateral (and, if necessary, also the inferior) wall of the sigmoid groove is first removed, until the lowest part of the sinus is reached; then the bone lying immediately above the end of the sinus is shaved off in thin layers, care being taken not to remove more than a thickness of $\frac{1}{2}$ centimetre, lest the posterior vertical semicircular canal be injured. In this manner the posterior wall of the bulb is exposed as far as the roof of the jugular fossa. A narrow bony projection, corresponding to the bend of the sinus at its junction with the bulb, still remains and must be removed, as well as the overhanging edges of bone all round the bulb. This can best be done with a bone forceps. The operation is, of course, rendered much easier if the bulb is filled with a thrombus and the sinus can be slit open. If this is feasible the extent of the bulb can easily be determined with a bent probe. The membranous walls of the sinus and the jugular bulb are then excised as far as possible, and the clot is cleared out. If the anatomical conditions are favourable, it is possible to obtain a view down as far as the beginning of the jugular vein.

Before the methods mentioned above were described by their

* *A. f. O.*, Bd. liii., 'Die Operative Ausräumung des Bulbus Jugularis,' etc. (F. C. W. Vogel, 1904).

† *A. f. O.*, Bd. liv.

‡ *Ibid.*, Bd. lviii.

§ *Z. f. O.*, Bd. xlviii., H. 3.

authors I treated (in 1898) a case of severe pyæmia in which I found on operation signs of thrombosis in the jugular bulb. I exposed the bulb somewhat after the manner of Grunert, with intentional destruction of the facial nerve, but without ligature of the jugular vein. The patient died five weeks after the operation.

When I come to the conclusion that there is a thrombus blocking the lumen of the bulb and setting up a general pyæmic infection, or that a decomposing clot has extended downwards from the sinus, I first tie the jugular vein and then try to expose and open the bulb by Voss's method. Moreover, I do not hesitate to remove the bone covering the facial nerve behind, if it is necessary to do so, and if the anatomical relationships allow it. If a small flat chisel is used and an assistant is instructed to watch carefully for twitching of the face, there is but little risk of injuring the nerve. In one case, following Grunert's method, I dissected with a blunt instrument down to the base of the skull and obtained a good view of the bulb without injuring any of the neighbouring structures. Up to the present I have never found it necessary to join the wound behind the ear with the incision over the jugular for the purpose of making a single groove of the vein and the sinus. In my opinion this operation is only necessary when there is no other means of removing the thrombus from the vein, and when the vessel wall itself is diseased. In the latter case the whole vessel must be excised, but as a rule splitting the vein as high up as possible suffices.

Thus the surgeon may hope, when he has freely exposed the bulb and its contents, to get rid of the focus of disease which has continually sent out fresh infective material into the circulation. This will save the patient, provided that his system is capable of overcoming the general infection which already exists. All further efforts must be directed towards improving the patient's general condition and supporting his strength.

Speaking generally, however, the prognosis in severe cases of septico-pyæmia remains distinctly unfavourable. Continued pyrexia, dryness of the wound, small amount of slimy discharge and a greenish-grey discoloration of the bone, are all signs which even at the first dressing warn the surgeon not to expect a good result. In a streptococcal infection the prognosis is even worse than in other forms. It causes no metastases, but runs its course as septicæmia, with continued high fever.

Ligature of the Jugular Vein.

Zaufal pointed out in 1880 that in certain cases of sinus thrombosis—namely, when the lumen is not shut off at the cardiac end—the ligation of the jugular vein should be undertaken in addition to the opening up and clearing out of the lateral sinus.

More than two decades have passed since then. Our knowledge and experience of pyæmia resulting from otitis have enlarged considerably, but there still remains a difference of opinion as to this part of the operation. Leutert, Grunert, Hansberg and others tie the jugular in every case of sinus thrombosis; while Jansen, Brieger, von Bergmann, Macewen and Körner hold that certain very definite indications should be present. From my experience in Lucae's clinic I must agree with the latter group of surgeons.

It would seem that the question could be most easily settled by studying the statistics of cases, and this has been attempted by Viereck. From his results the balance of evidence seems to be in favour of tying the vessel, but I consider that the total number of cases is far too small to allow of definite conclusions being drawn. Further, Viereck contrasted, on the one hand, the cases in which the sinus operation and ligature of the jugular were combined, and, on the other hand, all operated cases, whether the sinus was cleared out or only incised. It is certain that incision alone will effect a cure in only a very small number of cases.

A collection of cases from Lucae's clinic gives a different result. Up to the end of the year 1902, ninety cases of sinus thrombosis were treated. We must leave out of account at least sixteen of these, in which death was proved to have occurred from some other disease. Of the remaining seventy-four patients, thirty-six recovered and thirty-eight died. In six of the patients who recovered and in eight of those who died the jugular vein was ligated. If we had tied the vessel more often and had chanced in doing so on cases which would have recovered in any event, the results would have seemed to be in favour of ligature.

Further, I must remark that in the number of cases of sinus thrombosis given above I have only included those in which the presence of a thrombus was conclusively proved, either by operation or post-mortem examination. If I had added all the cases in which the symptoms pointed to sinus thrombosis, but the vessel was not opened, the number of recoveries without ligature would be much greater.

We see, therefore, that statistics cannot throw any light on the value of ligature of the jugular vein. This statement would hold good even if a very large amount of material was available for comparative study, for the conditions and indications for operation are not everywhere the same. Moreover, I quite agree with Körner that 'a surgeon is not justified in operating on a large number of patients according to fixed rules in order to test a theory.'*

As a matter of fact, statistics are not necessary for the purpose of estimating the value of ligature; clinical experience gives us sufficient information. When Zaufal first described the operation for sinus thrombosis, he believed that when the jugular was tied the main path for the spread of infection was closed. Admittedly, one way is thus blocked, but it is quite possible that the other ways may be important also. Brieger† quotes Genzmer's experiments, which show that aspiration of air into the lateral sinus is not prevented by compression of the jugular vein, and there is thus a possibility of bacteria, emboli or air-bubbles travelling into the superior vena cava *via* the occipital sinus, the dorsi-spinal venous plexus, the vertebral and innominate veins.

Many writers underestimate the importance of the collateral circulation and of the back-flow. Some even state that it is impossible for metastatic deposits to be carried in a direction opposite to the normal course of the blood-stream. It is well known that fever and rigors often persist after ligature of the jugular vein, but these are mostly put down to metastases which were formed before the operation. The autopsy, however, provides a different explanation in many cases. The direct path to the heart is found to be closed, but it is obvious that fresh infective material has entered the circulation from the emissary veins, from the other sinuses of the petrous bone and even from the distal end of the decomposing thrombus, which has been found extending as far as the lateral sinus of the opposite side.

The importance of the collateral circulation and the back-flow is further illustrated by those cases in which pyæmic fever and rigors persist after the closure of the lower end of the sinus, but cease as soon as its contents have been cleared out. Warnecke‡ published two such cases from Lucae's clinic. In one of these the lumen of

* 'Otitische Erkrankungen,' 3 Auflage, S. 125.

† *Z. f. O.*, Bd. xxix., S. 154.

‡ *A. f. O.*, Bd. xlviii.

the sinus was obliterated both above and below, but several small tributary veins were thrombosed; in the other the cardiac end of the vessel was firmly closed by connective tissue, while the thrombus extended backwards in the lumen for a considerable distance. In this latter case the chills and fever (having lasted in all for five weeks) continued right up to the time of the operation, a severe rigor occurring the night before. As the lower part of the sinus was closed, it is evident that infective material reached the general circulation from the distal end of the thrombus. A case on which I operated is similar to these. The cardiac end of the clot was healthy and the wall of the sinus between the clot and the jugular bulb appeared sound, but both the vessel wall and the thrombus showed a greenish discoloration in the neighbourhood of the torcular Herophili.

Cases of this kind are not rare, although the closure of the lumen with healthy connective tissue cannot always be demonstrated so satisfactorily. In his earliest works on the subject Jansen pointed out these cases, and at first he thought that they were the rule. Under these conditions ligature of the jugular vein only adds a second closure of the vessel nearer to the heart and this has no additional advantages.

Some surgeons—*e.g.*, Grunert, Hansberg—make a rule of tying the jugular before every sinus operation to prevent all danger of embolism. Hansberg* considers that ligature of the vessel is indispensable. He admits that it may have dangerous consequences, but says that these may be avoided if proper precautions are taken.

There is no doubt that in his manipulations on the sinus the surgeon may set free embolic particles from the clot, but I do not think that this accident occurs often enough to make ligature always necessary. In a few cases I have seen rigors after interference with the sinus, but metastases were never observed. If the whole thrombus is removed, the strong rush of blood will generally sweep all loosened particles out of the wound, while if the solid part of the clot is left *in situ* we may assume that none of it will become detached. The firm, smooth appearance of these clots when found post-mortem is in favour of this supposition. If there were really much danger of embolism, the impact of the chisel would be strong enough to loosen the embolus and, in order to act logically, we should tie the jugular in every case before opening up the mastoid. This,

* *Z. f. O.*, Bd. xlv.

however, is not feasible in view of the difficulties which often attend the diagnosis of sinus thrombosis.

Thus, the operation is sometimes only partially effective and in some cases superfluous. Further, it is not without danger and must not be undertaken unless precise and certain indications are present.

Jansen* first called attention to the possibility of the spread of an infective thrombosis from the jugular bulb into the inferior petrosal sinus as the result of ligature of the vessel. He adduced as evidence a case from our clinic and since then we have had a second case which demonstrates still more clearly this retrograde extension of the thrombosis. In my paper on the operative treatment of sinus thrombosis I described this case in detail, so that it is only necessary to give a brief account of it here.

A girl of seventeen, the subject of chronic middle-ear suppuration on the left side, developed pyrexia, rigors, vomiting, headache and rigidity of the neck muscles. The operation brought to light a cholesteatoma, which had infected the sinus. The decomposed masses of clot were removed from the vessel until strong hæmorrhage took place from both the peripheral and central ends. As the temperature still remained high, the jugular and the common facial veins were tied on the following day. That evening the first signs of cavernous sinus thrombosis made their appearance, and the next morning the picture was complete: bilateral exophthalmos, œdema of the eyelids, and chemosis were present. Death occurred two days after the ligation of the veins. In the bulb were found slimy masses which extended through the inferior petrosal into both cavernous sinuses, and even as far as the superior petrosal sinus of the opposite side. No metastases were found and death was therefore due to severe general sepsis.

As soon as the rapid advance of septic thrombosis towards both sides was definitely diagnosed, we were forced to conclude that the lumen of the vessel was not properly closed at the cardiac end, or if it were closed that the clot blocking it must soon break down. The jugular was therefore tied, the blood in it being found to be in a fluid state. The immediate result was that symptoms of thrombosis in the cavernous sinus made their appearance. They set in so quickly that the thrombosis was evidently due to the ligature of the jugular vein. This supposition was confirmed by the fact that

* *Sammlung Klinischer Vorträge von Volkmann*, No. 130, S. 246.

the general condition of the patient, which was fairly good up to the operation, became very much worse afterwards. When the first operation was performed the strong hæmorrhage proved the jugular bulb to be free from clot. The condition of the vein at the time of ligature makes it very probable that the bulb was then still free. If the bulb is blocked as far as the mouths of the inferior petrosal sinus and the anterior condyloid vein, the jugular is found to be empty and collapsed down to the point where the next tributary joins it. Even if we take into consideration the extreme malignity of the thrombus and the rapid advance of the inflammatory process in the vessel wall, these do not account for the sudden appearance of the cavernous sinus symptoms and the rapid advance of the thrombosis into the petrosal sinus. The damming of the blood-stream and the formation of a clot in the bulb must have contributed largely to the result. It would have been useless in this case to open up the vein as far as the base of the skull, as recommended by Jansen, Brieger and Hansberg. There was reason to believe that the flow of blood from the tributary vessels was uninterrupted, and if the vein had been split up we should have had free hæmorrhage, making a tight gauze packing necessary. In this way the conditions in the bulb would be in no way improved.



Brieger,* too, has reported a case in which extensive thrombophlebitis in the petrosal sinuses followed obliteration of the jugular vein. He believes that the tying of the vein directly favoured the spread of thrombosis and inflammation. I must also mention a case from Schwartze's clinic, in considering which we are forced to the conclusion that the peripheral spread of the thrombosis was aided by the ligature, although the authors† who published the case make no reference to a causal connection between the two. After the jugular had been tied, an incision was made in the sinus from which the blood flowed freely obscuring the thrombus. The authors go on to state that 'the lower end was then packed with iodoform gauze.' This shows that hæmorrhage was coming from the bulb which was therefore not then blocked with clot. On the fifth day a part of a rib was resected, and at least 2 litres of stinking ichorous fluid removed from the pleural cavity. Death from syncope occurred one and a half hours later. At the autopsy a fresh-looking thrombus was found adhering to the wall of the

* *Z. f. O.*, Bd. xxix.

† Grunert and Schulze, *Jahresbericht*, 1900-1901, Fall vii., S. 97.

sinus. In the bulb and upper part of the jugular vein were slimy, fetid masses of clot which extended into the superior petrosal and cavernous sinuses of both sides.

In the description of my own case given above I think I have proved, at any rate, that it is possible for the thrombosis to penetrate into the inferior petrosal sinus as a result of tying the jugular vein. This danger is therefore to be taken into account, no matter how rare the occurrence may be. Unfortunately, the spread of the process into the tributary vessels is particularly to be feared when the thrombus is septic and has a tendency to decompose rapidly. Thus, in the very cases in which ligature is most definitely indicated to prevent pyæmia it is liable to lead to bad local results.

But even if thrombosis has not taken place, the sudden stoppage of the venous blood-flow may endanger the patient's life, especially if the collateral circulation is imperfect. Rohrbach* has published from Brun's clinic a case in which the left internal jugular vein was tied for carcinoma of the glands of the neck. The patient died on the sixth day after the operation, without ever having recovered consciousness. The autopsy showed congestion necrosis in the brain, due to abnormal narrowness of the lateral sinus and of the internal jugular on the sound side. The lumen of the former was only as large as a knitting-needle; the vein near the base of the skull just admitted the end of a crow-quill. From the same clinic Linser† reported a second case in which, during an operation for goitre, the right internal jugular was ligatured. Death occurred the same evening from œdema of the brain. The circumference of the vein that had been tied was 4·4 centimetres; of the jugular on the other side 1·8 centimetres. Linser subsequently examined 1,022 skulls, and found that in 3 per cent. of them one jugular foramen was markedly narrow, with a diameter of 3 to 4 millimetres. This abnormal narrowness was observed five times more often on the left than on the right side. He therefore comes to the conclusion that ligature of the jugular vein is not by any means such a safe operation as is generally supposed. Hölscher‡ thinks that the danger is not very great, since the lumen of the affected sinus is already blocked before the operation. He does not take account of the fact that many surgeons tie the jugular in cases of parietal thrombosis when the lumen is more or less free.

* Bruns, *Beiträge zur Klinischen Chirurgie*, Bd. xviii.

† *Ibid.*, Bd. xxviii.

‡ *A. f. O.*, Bd. lii., S. 129.

It appears, therefore, that ligature of the jugular vein does not always produce the desired results, and is to a certain extent dangerous. Further, a large number, if not the majority, of patients suffering from sinus thrombosis recover if the sinus is opened and cleared out without ligature of the vein. Hence the operation should only be undertaken when it is very definitely indicated. Moreover, we must remember that, although the exposure and ligature of this large vein may be easy for a practised surgeon, the operation may be fraught with considerable difficulty for a beginner. Injuries to the jugular vein itself and to neighbouring structures may, perhaps, have occurred more frequently than a study of the literature of the subject would lead us to believe. Finally, we are not justified in disfiguring a patient's neck with a long scar, especially if the patient be a young girl, unless the operation is absolutely necessary.

In my opinion ligature of the internal jugular vein is definitely indicated in cases where primary or secondary thrombosis has filled up the lumen of the jugular bulb and has given rise to severe general pyæmic infection. Again, it is indicated when the vein itself is found to be thrombosed. In both these types of case the vein should be tied before the sinus operation is begun, if a definite diagnosis can be made, and the ligation should invariably be followed by free exposure and clearing out of the bulb.

In the second place, I consider ligature justifiable in cases in which the thrombus is accessible down to its lower end, but cannot be removed owing to the free hæmorrhage from the bulb. Under these circumstances, the vein should be tied immediately if the thrombus is decomposed and the wall of the sinus discoloured; otherwise, the temperature must be our guide. If (after the radical operation) it remains high, or falls and then rises, or, *a fortiori*, if there is a rigor, the vein must be ligatured at once. In these cases, too, opening up of the bulb and of the jugular vein must be carried out as soon as the patient's condition allows.

In cases of parietal thrombosis in the lateral sinus or in the bulb, ligature of the vein is only justifiable when severe pyæmic symptoms persist after the exposure of the sinus and the opening of the periphlebitic abscess. No rigid general rule can be laid down for these cases; each must be treated on its merits. Naturally, if it is in any way feasible, the focus of suppuration in the sinus should be removed.

The operation itself is carried out as follows: A sand-pillow is placed under the patient's neck, so that the skin is stretched and the sterno-mastoid muscle stands out distinctly. An incision 6 centimetres in length, with its centre opposite the cricoid cartilage, is then made along the anterior edge of the muscle. In doing this care must be taken that the skin is not pulled to one side by the left hand. If the incision is made too far back, it is easy during the operation to get in between the bundles of muscle fibres and to miss the vessel altogether. The subcutaneous connective tissue and the platysma having been divided, the anterior edge of the muscle comes into view. A blunt hook is passed over this edge and the muscle drawn backwards, when the carotid sheath should be seen. If it cannot be recognized clearly, the pulsating artery must be felt for. The internal jugular vein lies behind and to the outer side of the artery, the vagus nerve running deeply between them. The carotid sheath is picked up with a toothed forceps and a small cut is made in the fold which has been thus raised. The incision is then enlarged with the handle of the knife and the vein exposed to a point above its junction with the common facial—*i.e.*, to the extent of about 3 or 4 centimetres. Pressure on the side of the neck below the wound causes the veins to stand out and makes them easy to identify. Two ligatures should be applied to the jugular above the common facial and two to the latter vein, and both vessels divided between the ligatures. If the thrombus appears to extend far down into the jugular vein, it is better to put a ligature also below the facial, and to resect the Y-shaped portion of vein thus shut off from the circulation.

The skin wound is not sewn up, but loosely packed with iodoform gauze.

2. THROMBOSIS OF THE CAVERNOUS AND PETROSAL SINUSES.

Retrobulbar œdema with exophthalmos, œdema in the region of the frontal vein and of the eyelids, and chemosis are the symptoms by which thrombosis in the cavernous sinus becomes manifest. To these may be added symptoms due to irritation of the nerves which are in relation to the sinus. According to Körner, neuralgia of the first division of the trigeminal and paralysis of the abducent, the

trochlear and the oculomotor nerves have been observed. It is not possible to diagnose thrombosis of the petrosal sinus.

An operation for cavernous sinus thrombosis is conceivable, but none such has as yet been successfully carried out. Bircher* published a case, but Körner considers it to have been merely one of suppuration in the neighbourhood of the sinus. F. Voss† exposed and opened the thrombosed cavernous sinus following Lexer's modification of Krause's method for intracranial resection of the Gasserian ganglion. The patient died of meningitis, which was present before the operation.

* *Centralblatt für Chirurgie*, 1893, No. 22.

† *Centralblatt für Ohrenheilkunde*, Bd. i., S. 186.

CHAPTER III

OPERATIVE TREATMENT OF CEREBRAL ABSCESS

DIAGNOSIS—OPERATION—AFTER-TREATMENT.

DIAGNOSIS.

IT would be outside the scope of this book to discuss in detail the complicated symptomatology of cerebral abscess due to otitis media. I must confine myself to giving a general review of the subject. Exhaustive descriptions will be found in the text-books of von Bergmann,* Körner,† Macewen‡ and Oppenheim.§

The clinical course of a cerebral abscess may be divided into four stages, as follows :

1. The **initial** stage, in which the abscess causes symptoms ; but these are of such a general nature that they might be due to the chronic middle-ear disease alone.
2. The **latent** stage with no special signs.
3. The **manifest** stage, in which the symptoms become fully developed.
4. In the **terminal** stage the hitherto localized suppuration becomes diffuse. Purulent meningitis is set up by perforation of the abscess out to the surface or the pus breaks into the ventricles. Perforation inwards may be sufficient to cause death without meningitis.

* 'Die Chirurgische Behandlung von Hirnkrankheiten,' 3 Auflage, 1899.

† 'Die Otitischen Erkrankungen des Hirns, der Hirnhäute und der Blutleiter,' 3 Auflage, 1902.

‡ 'Pyogenic Infective Diseases of the Brain and Spinal Cord.'

§ (a) 'Die Encephalitis und der Hirnabscess,' 1897 ; (b) 'Lehrbuch der Nervenkrankheiten,' 3 Auflage, 1902.

The most convenient classification of the symptoms of brain abscess is that suggested by von Bergmann. He divides them as follows :

- I. General or systemic symptoms.
- II. General symptoms of cerebral disturbance or compression.
- III. Local cerebral symptoms.

I. Among the general symptoms the most important is variation of the temperature from the normal. As in suppurative meningitis, the beginning of pus formation may be marked by a rigor. In one case I was led to diagnose meningitis incorrectly by the occurrence of a rigor, followed by pyrexia, with stiffness of the neck and partial unconsciousness lasting for several days. It was only when the temperature had fallen and definite localizing symptoms became marked that the presence of an abscess became absolutely certain. It is even possible that there may be more than one rigor, but, speaking generally, both rigors and high fevers are rare. When pyrexia does occur it may be due in some way to the original otitis media—for instance, by retention of discharges—or to serous meningitis (Leutert). As a rule, however, an uncomplicated cerebral abscess will run its course with a normal, or more frequently a sub-normal, temperature (Barker, Hulke, Macewen).

Other signs of disturbance in the patient's general health are languor and depression, wasting, sallow complexion, loss of appetite, constipation and oral fetor.

II. The general cerebral symptoms are the result of increase of pressure in the brain. One symptom which is practically never absent, and appears at an early stage, is **headache**. It may be observed in all stages of severity in the same patient. At one time it may be only a dull feeling of pressure in the neighbourhood of the diseased ear, while at other times there are intense and almost unendurable attacks of pain. The pain may be strictly localized to one part —e.g., to the region of the temporal lobe—or it may radiate over the whole head. The most painful spot does not always correspond to the position of the abscess. According to Körner, a cerebellar abscess may cause frontal headache, while, conversely, an abscess in the temporal lobe may give rise to pain in the occiput.

Percussion of the head gives an important clue to the position of the **focus** of suppuration. Thus von Bergmann, Macewen, Kümmel and others, have observed that a patient with an abscess in the temporal lobe suffers severe pain on percussion over the temporal

Tain
cerebral
abscess.

region. **Rigidity of the neck muscles** and pain on bending the head forwards are most often found in cerebellar abscess, but may also be caused by abscess in the cerebrum.

Nausea and vomiting are most common in the early stages of the disease; they may, however, also occur later, sometimes in combination with the attacks of pain mentioned above. **Vertigo** occurs in connection both with cerebral and cerebellar abscesses, but most commonly with the latter, and in the form of the so-called 'cerebellar ataxy.'

Convulsions are rare, occurring as a rule only in children. On the other hand, **mental and sensory disturbances** are practically never absent. At first the patient only appears drowsy, yawns frequently and sleeps much; he is apathetic, answers slowly and with hesitancy; his memory fails him. Later on this slight mental dulness passes into well-marked somnolence, stupor or coma. He has alternating periods of perfect clearness and complete unconsciousness. A stage of absolute coma usually precedes death.

A slow pulse is an important diagnostic sign, but in many cases the pulse-rate departs by little or nothing from the normal. Moreover, the surgeon must bear in mind that in many individuals the pulse is slow even in perfect health.

Optic neuritis or congestion papilla may often be demonstrated; in other cases, however, and often when there is an extensive abscess, these signs are absent. Thus, only positive results from the examination of the fundus oculi are useful in the diagnosis.

III. Körner divides the local brain symptoms into three classes: (a) those caused by direct injury to a particular part of the brain; (b) those caused by indirect cerebral disturbance; and (c) those caused by injury to the cranial nerves within the cavity of the skull.

(a) Cerebral abscess of aural origin is generally found in the temporal lobe or in the cerebellum.

Disturbances of hearing through involvement of the auditory centre in the temporal lobe have but rarely been observed—according to Körner, only in four cases. One of my patients, who had a temporal abscess on the right side, suffered from well-marked auditory hallucinations, most probably due to irritation of the centre. In the same patient the hearing in the sound ear became affected during the long after-treatment.

If the abscess is in the left temporal lobe, the most marked symptoms in most cases will be sensory derangement of speech. Amnesic and optic aphasia* and paraphasia, sometimes combined with agraphia, alexia and anarhythmia, have been observed and described more frequently since attention has been called to the frequency of their occurrence. These derangements of speech are due, according to Oppenheim, 'to a lesion of the sensory speech centre, or to the interruption of the paths which join this centre to other parts of the cortex.'

Only one case has been reported so far in which an abscess in the right temporal lobe caused these symptoms in a right-handed person. This patient was operated on by me in Lucae's clinic and recovered.† According to Körner, true word-deafness has only been observed twice, and motor aphasia never, in uncomplicated cases of abscess due to otitis. A cerebellar abscess may give rise to the typical ataxia and dizziness. Often, however, it causes no localizing symptoms, and may be found quite unexpectedly at the post-mortem examination.

(b) Indirect disturbances of the brain result not only from pressure by the abscess on neighbouring cerebral substance and increased pressure in the cerebro-spinal fluid (von Bergmann), but also, without doubt, from encephalitis and softening round the focus of suppuration. Thus in temporal lobe abscess we find lesions of the internal capsule. Körner states that these lesions give rise 'to paresis of the extremities on the opposite side (rarely crossed paralysis), crossed spasms and convulsions, and tonic contraction on the opposite side. Added to these are paresis and sometimes spasms in the region supplied by the opposite facial nerve, and occasionally hemianæsthesia and homonymous bilateral hemianopia.'

The hemianopia is not necessarily always due to involvement of the optic tract; in some cases, where the abscess is very far back and extends into the occipital lobe, a subcortical lesion of the optic radiations may give rise to this symptom.

On these lines an explanation can be found for the case, already mentioned, of right-sided temporal abscess with sensory aphasia. Besides the abscess in the temporal lobe, we found another reaching as far as the apex of the occipital lobe.

Cerebellar abscesses may cause indirect disturbances by pressure

* Oppenheim, Pick.

† 'Verhandlungen der Deutschen Otologischen Gesellschaft,' 1903.

on the pons, the crura of the cerebellum and the medulla oblongata. Oppenheim states that the principal symptoms caused in this way are interference with the power of looking towards the affected side, alternating hemiplegia and dysphagia, and dysarthria. When the medulla is compressed, disturbances of respiration, or even death through total inhibition of the respiratory centre, may result.

(c) The nerves which are most likely to be compressed at the base of the skull by a cerebral or cerebellar abscess are the oculomotor (generally bilateral mydriasis and ptosis) and the abducent. Further, bilateral paralysis of the hypoglossal and trigeminal neuralgia have been observed in a case of temporal lobe abscess. Facial paralysis may occur if a cerebellar abscess compresses the nerve close to the internal auditory meatus.

General Considerations.—Having considered the complicated symptomatology of cerebral abscess, the question arises whether the condition can be diagnosed easily and with certainty. Unfortunately, the answer must be in the negative, in spite of the rapid advances which our knowledge of the subject has made within recent years. A certain diagnosis is only possible in the manifest terminal stage, and even then the localizing symptoms, which are the most important, are often absent. The general symptoms are more or less the same in all cerebral affections of aural origin, and do not allow of definite conclusions being arrived at. In many cases it is only on operating that the surgeon can make a definite diagnosis.

The suppurative condition which can be most easily identified is an abscess in the left temporal lobe, on account of the sensory disturbances of speech to which it gives rise. But we must remember that serous encephalitis, which may be set up by inflammation outside the membranes, sometimes causes these same symptoms, as I have pointed out in the section on extradural and subdural abscess. Paresis of the right oculomotor nerve suggests the presence of abscess in the right temporal lobe.

In children the differential diagnosis presents many difficulties. It is not easy to make out the localizing symptoms accurately, and even if they are made out it is quite possible that they are due to extradural abscess or serous or suppurative meningitis. Further, intracranial tuberculosis in children and brain tumours in adults, if they coexist with purulent otitis media, may lead the surgeon to diagnose cerebral abscess wrongly.

Cerebellar abscess and uncomplicated labyrinth suppuration may both manifest themselves by vertigo, ataxia and nystagmus (Körner). The most careful weighing of all the symptoms is often necessary in order to avoid error. Neumann* believes that a sure diagnostic sign is to be found in the varying type of the nystagmus.

In labyrinth suppuration the nystagmus towards the affected side† decreases or disappears altogether with the advance of the destruction of the vestibular apparatus, while in cerebellar abscess it increases in proportion as the abscess extends. Further, when in a case of labyrinth suppuration there is nystagmus towards both sides, the component towards the affected side disappears gradually, while that towards the sound side remains. On the other hand, when a cerebellar abscess is present, the nystagmus which was at first towards the sound side suddenly changes to the opposite direction.

The introduction of lumbar puncture has made the diagnosis between brain abscess and purulent meningitis very much easier, but even by this means we are not absolutely guaranteed against mistakes. Further, we must not forget that patients suffering from both hysteria and suppurative otitis media are very apt to present a series of symptoms which may lead us to a wrong diagnosis of cerebral abscess.

In view of this uncertainty, the safest practice in doubtful cases is to open up the middle-ear spaces as early as possible. The appearance of the interior of the bone often makes everything clear. Naturally this rule of early operation does not hold good for patients who are undoubtedly hysterical.

THE OPERATION.

In order to expose a brain abscess two routes are open to the surgeon. One leads directly to the abscess through the corresponding part of the surface of the cranium; the other is by way of the mastoid cavities.

The first route is preferred by most general surgeons by analogy with the method of opening ordinary abscesses. To open the middle fossa von Bergmann recommended a curved incision round the upper part of the ear, beginning at the tragus in front and ending

* *A. f. O.*, Bd. lxvii., S. 191.

† In some cases the nystagmus is towards the sound side as well.

behind at the apex of the mastoid process. The auricle is then detached and turned downwards, until the upper and posterior edge of the bony meatus and the whole of the temporal ridge are exposed. A large rectangular piece of bone (4 centimetres long by 2 to 2·5 centimetres in height) is then removed from the squamoid, its lower border being on the level of the floor of the middle fossa. When this has been done the temporal lobe can be raised up, allowing the floor of the fossa and its dura mater to be examined. An abscess if present can be opened and emptied of its contents and the diseased mastoid and tympanic cavity may even be cleared out after removal of the tegmen antri and tegmen tympani.

The cerebellum may be easily exposed by opening the posterior cranial fossa immediately behind the posterior border of the mastoid process—that is, below and behind the upper bend of the sinus. I will discuss this operation more in detail later on.

To reach the affected part of the brain aurists prefer the second route, which seems to be beyond doubt the more appropriate, since it is the way by which the inflammatory process has entered the cranial cavity. By following it we first eliminate the causative focus of disease in the mastoid antrum and in the middle ear, and gain access to the brain through these spaces. Further, this method seems the most rational, on account of the uncertainty of the diagnosis, which compels us often to expose the dura merely for purposes of exploration. If there is no sign of brain trouble, the operation can be broken off at this stage and the ordinary after-treatment carried out.

Thus, von Bergmann's dictum that no attempt should be made to open an abscess until its exact situation has been determined does not hold good for the cases now under discussion, in which the exploratory operation may be done without any danger. The procedure is as follows: The opening up of the mastoid (or, since most brain abscesses are due to chronic suppurative otitis media, the radical operation) is first completed. The dura mater of the temporal lobe is exposed in the neighbourhood of the tegmen tympani or tegmen antri and carefully examined. If it is found to have undergone pathological change (it may be covered with granulations, or may be greyish-red in colour, or even dark green and gangrenous-looking), more bone must be removed with a bone forceps until the healthy membrane is reached. Pulsation is now looked for; if it is absent, we have a very suggestive, although not absolutely certain, sign of

an abscess lying close to the dura mater. A deep abscess, on the other hand, does not necessarily arrest pulsation.

If an abscess is suspected, the temporal lobe is next punctured with a needle attached to a syringe. Several surgeons, including von Bergmann and Körner, reject syringe puncture in favour of exploratory incision. They consider the latter to be more reliable because a fine cannula may easily become blocked with thickened pus or portions of softened brain substance. This objection must be admitted, and I myself once had a case in which I punctured a cerebellar abscess, but failed to draw pus into the syringe. The autopsy proved that the cannula had really been in the abscess cavity. Since then I have used large-bore needles, and I have had no second case in which puncture failed. Incision, on the other hand, is always a more serious matter, and I believe it is more apt to lead to infection than is simple puncture, especially if the abscess is deeply situated. I have recently learned, too, that exploratory incision is not absolutely reliable. An abscess in the temporal lobe was found by puncture, but when a scalpel was inserted to the same depth and in the same direction the result was negative. A second and deeper incision was necessary before the abscess cavity emptied itself.

This seeming anomaly can, I think, be explained in the following way: The abscess was very deeply situated; the point of the needle had penetrated $2\frac{1}{2}$ centimetres deep, and had just reached the abscess cavity, so that pus was aspirated into the syringe. The point of the knife, however, which had been inserted to the same depth as the needle, made such a small opening in the wall of the abscess that the pus was unable to make its way out through the thick layer of normal brain substance.

In making the exploratory puncture the dura need not be incised; the needle may be driven through it. I have never seen any ill-results from carrying out the operation in this way. If the puncture at first gives no result, it must be repeated in various directions. Körner believes that the needle should not be allowed to penetrate beyond a depth of 4 centimetres, on account of the danger of injuring the lateral ventricles. In my opinion the surgeon ought not to feel himself unalterably bound by this measurement, especially if there are definite localizing symptoms pointing to the presence of an abscess. I once saw a case in which the median wall of the abscess cavity was 7 centimetres distant from the dura mater. Since then I should not hesitate to insert the needle to this depth if necessary.

If an abscess is found, the bone must be further removed with a bone forceps until the temporal lobe is exposed from the ostium of the Eustachian tube to the lateral end of the upper edge of the petrous pyramid. The use of the chisel is to be avoided as much as possible. The concussion may easily cause perforation into the ventricle.

The dura is now split in the long axis of the temporal lobe, or an incision is made directly through the membrane into the abscess. More or less pus or ichorous fluid will now flow out. Free discharge may be facilitated by inserting into the wound in the brain a closed dressing forceps and opening the blades cautiously in the abscess cavity. The upper margin of the wound should then be raised, and the surgeon should attempt, by the aid of concentrated artificial light, to obtain a view of the interior of the abscess. I do not recommend digital exploration, but content myself with swabbing out the cavity gently until it is free from pus. Finally, a large drainage-tube wrapped in iodoform gauze is inserted so that it does not quite reach to the median wall of the abscess. This is best done by pushing the tube forwards carefully until it touches the wall and then drawing it back a little. A thick probe should be passed in to make sure that there is no kinking of the tube, which is then cut off at the level of the skin. The outer part of the wound is loosely filled with gauze and a loose dressing applied.

Neither puncture nor exploratory incision is necessary when the pus has already perforated the dura and can be seen flowing out through a fistulous opening.

In some cases when the radical operation is completed the dura mater is not found to be exposed. If the bone covering the membrane is diseased, it must be removed, and the operation completed or an exploration made, as already described, according to the symptoms and condition of the dura. If, on the other hand, the bone appears healthy, the dura should not be exposed unless the symptoms are such that they cannot be explained by the middle-ear disease, but suggest the presence of some intracranial complication.

In doubtful cases the surgeon should always remember that brain abscess is a relatively rare condition, whereas *general cerebral* symptoms which may seem to point to abscess are exceedingly common in middle-ear suppuration.

Macewen, von Bergmann, Hansberg and Körner are in favour of

making a second opening into the abscess by removing part of the squamoid bone. Up to the present I have found the opening through the floor of the middle fossa sufficient. On the other hand, I think that certain cerebellar abscesses should be opened and drained through the immediately overlying bone. This second aperture is required when the outflow from the opening corresponding to the posterior surface of the petrous bone is insufficient, while at the same time the abscess may be assumed to be fairly superficial. If the cerebellum has already been made accessible through the mastoid, it is not difficult to expose it from the surface as well. All that is necessary is to chisel away the posterior border of the opening in the mastoid process until the upper bend of the sinus is found, and then to remove the bone in a downward and backward direction.

With this exception, the operation for cerebellar is exactly similar to that for cerebral abscess—namely, opening and evacuation through the mastoid. Unfortunately, only a small part of the cerebellum can be exposed in this way, because the field of operation is limited in front by the posterior vertical semicircular canal (or if this has been destroyed, by the internal auditory meatus) and behind by the lateral sinus. The vessel must be exposed for part of its descending course, in order that the surgeon may clearly distinguish on the median side the junction of its wall with the cerebellar dura. The division is often difficult or impossible to identify, especially when there is an extradural abscess in the posterior fossa, and both sinus wall and dura are thickened and altered by pachymeningitis. They both appear reddish-grey and a bulging of the sinus wall cannot be observed.

Some further information may be gained by exposing the sinus upwards until healthy tissue is reached and endeavouring to follow its course.

When the way to the cerebellum has been found, exploratory puncture in various directions and incision should be carried out, just as in dealing with the temporal lobe.

AFTER-TREATMENT.

Unfortunately, there is no certain guarantee that the abscess will heal up as soon as it is opened and its contents evacuated. On the contrary, the after-treatment is very difficult and often a most

thankless task. Just when we think that we have brought our patient safely through the danger, he may develop serious symptoms and succumb to an attack of meningitis. In a few of the cases which turn out badly there is a closed-in focus of inflammation, which was the original cause of the abscess; but in the great majority it is a question of spreading encephalitis round the cavity.

Care must be taken, therefore, to provide free drainage for the serous secretion from the wound and for the pus which is continually formed afresh by the casting off of diseased cerebral substance. Unfortunately, this cannot be done as perfectly as one might wish, because of the softness of the brain matter and the pressure within the brain. In the outlying parts of the cavity the walls fall together when the fluid contents have been removed and smaller cavities are formed, in which the secretions are retained. In a case of this kind it may happen that no pus appears at the surface for days, but nevertheless severe symptoms set in, compelling the surgeon to explore the wound in the brain with the result that a large amount of pus flows out from the deeper parts. I do not think it advisable to pack the wound with iodoform gauze, because even with good reflected light it is impossible to see into every nook and cranny of the cavity, and therefore the packing cannot be introduced into every part of the wound, as it should be if used at all. Further, the capillary action of the gauze is not sufficient to draw up the very large amount of secretion. Even when the wound is dressed daily there is often a rush of fluid when the gauze is withdrawn.

The rubber drainage-tube also has its disadvantages. If it is soft, it becomes flattened out; if it is too thick and rigid, it is liable to irritate the brain substance. In a few cases I tried glass tubes to obtain better drainage, but I found that they were very irritating.

Now, as a rule, as soon as the operation is completed, I introduce into the cavity a thick-walled rubber drainage-tube with a large lumen. Close to the end of the tube holes are made in its sides, so that the lumen may not be blocked if healthy brain substance should press against the end. A small amount of iodoform gauze is packed round the tube into the wound in the brain. If the hæmorrhage is very free, the whole cavity may be packed; but even if this is done at the conclusion of the operation, a drainage-tube must be substituted the first time the wound is dressed.

Neumann* recommends the introduction of strips of iodoform gauze soaked in hydrogen peroxide solution. He reports a case of cerebellar abscess in which retention of pus occurred repeatedly. When peroxide was used the vomiting and suppuration disappeared immediately and the evil odour ceased. Neumann ascribes this rapid improvement to the action of the nascent oxygen on the anaerobic micro-organisms.

The first dressing remains in position for two days; afterwards the dressings are changed daily. A fresh drainage-tube is introduced, and when this is being done the surgeon must see that there is no retention of pus. The tube must remain in as long as any pus is found in its lumen. Strips of iodoform gauze must not be substituted until the secretion becomes very small in quantity.

Prolapse of a portion of the brain is a most disagreeable accident which makes dressing of the wound exceedingly difficult. As a rule, the prolapsed tissue shrinks and goes back of itself. If it is very large, it may be necessary to remove it with a scalpel.

The best prognosis can be given in those cases in which the abscess lies near the dura, and the focal symptoms disappear soon after the operation. If this does not occur—for instance, if aphasic disturbances are only slightly improved—we may conclude, as a rule, that there is progressive softening of the cerebral tissues. This is very difficult to control when the abscess is situated deeply, on account of the impossibility of establishing proper drainage.

The prognosis in cerebral abscess is now much more favourable than it was formerly, when, except for the very rare accident of spontaneous evacuation of the pus, the patient was inevitably condemned to die.

From Körner's collection of cases it appears that something over 50 per cent. of the patients who were operated on recovered. He believes, however, that no definite conclusions can be drawn from the published cases, because those which turn out badly are rarely reported.

* *A. f. O.*, Bd. lxvii., S. 197.

CHAPTER IV

THE OPERATIONS FOR SEROUS MENINGITIS
(MENINGO-ENCEPHALITIS) AND FOR
SUPPURATIVE MENINGITIS

1. DIAGNOSIS AND OPERATIVE TREATMENT OF SEROUS MENINGITIS. 2. DIAGNOSIS AND OPERATIVE TREATMENT OF SUPPURATIVE MENINGITIS.
3. LUMBAR PUNCTURE. 4. PUNCTURE OF THE LATERAL VENTRICLES.

1. DIAGNOSIS AND OPERATIVE TREATMENT OF SEROUS
MENINGITIS.

UP to about the year 1890 meningitis of aural origin was considered to be an incurable disease. When once the diagnosis had been made with certainty, the surgeon had to make up his mind that his patient must surely die in spite of all care and skill. Experience since then has taught us that there are forms of this terrible disease which can be cured if an operation is performed at the right time. We used to believe that inflammation of the pia mater and arachnoid always led to purulent infiltration in the meshes of the former membrane. Through Quincke's lumbar puncture, however, we have become better acquainted with a form of meningitis in which the pathological product is merely an increased amount of cerebro-spinal fluid, causing a condition of hydrops in the ventricles.

It must be admitted that we have still much to learn about serous meningitis. Very few post-mortem reports are available, and those which have been published* are, according to Körner,† not complete enough to allow of definite conclusions being drawn from them. In

* By Leutert and Waldvogel.

† 'Otitische Erkrankungen des Hirns,' etc., 3 Auflage, S. 58 *et seq.*

other cases (such as those of Levi and Cassel) the disease may very well have been the intermittent form of purulent meningitis described by Brieger and Cohn.

In some of the published cases the symptoms pointed to disease of the substance of the brain, in others to an affection of the pia and arachnoid membranes, so that Körner suggests that we may be dealing with two different conditions—namely, serous meningitis and serous encephalitis. He bases his opinions on deductions of Merken, who holds that the toxins of an abscess in or on the brain may give rise to a localized serous encephalitis and a general leptomeningitis in the same way that a furuncle sets up collateral oedema in its neighbourhood. According to my own observations this explanation seems very plausible. Since both diseases coexist and cannot be separated clinically, I agree with Körner that we should speak in these cases, not of meningitis, but of serous meningo-encephalitis.

Up to the present it has not been possible to diagnose this disease with certainty. The symptoms sometimes point to suppurative meningitis (headache, vomiting, fever, stiffness of the neck, cramps, etc.), sometimes to brain abscess (focal symptoms, such as disturbances of speech, when the left temporal lobe is affected). Often only the condition seen during the operation and the results obtained give us an idea of the true nature of the disease. Lumbar puncture may be relied on to a certain extent for the purpose of diagnosis. If a patient has typical meningeal symptoms and clear sterile fluid under high pressure is drawn off from the spinal canal, there is a strong probability that serous meningitis is present. Yet it is always possible that there exists somewhere a circumscribed purulent leptomeningitis, which through its toxins has given rise to an increase in the amount of the cerebro-spinal fluid without altering its composition. In either case the result of lumbar puncture described above makes immediate operation absolutely necessary.

In most cases removal of the focus of suppuration from the middle ear and exposure of the affected portion of the brain are enough to cause the disappearance of the severe cerebral symptoms. We ought not, therefore, to be too free with exploratory operations on the brain, but should rather wait to see the results of the ear operation. When the presence of a labyrinth suppuration (according to Jansen a frequent cause of serous meningitis) can be demonstrated with certainty, it must be dealt with on the principles laid down in the chapter on labyrinthotomy.

Slight meningeal symptoms making their appearance after one of these operations need cause no special alarm. It is a well-known fact that in many cases, after an operation for suppuration in the temporal bone, the patient shows for a short time all the signs of serous meningitis. The surgeon should therefore wait to see if spontaneous improvement takes place before he proceeds to more extensive operative measures.

The operations for the removal of superfluous cerebro-spinal fluid are incision of the membranes, lumbar puncture and puncture of the ventricle. These will be described later.

2. DIAGNOSIS AND OPERATIVE TREATMENT OF SUPPURATIVE MENINGITIS.

Up to the present suppurative meningitis has been divided into two main classes—the circumscribed and the diffuse. I will give, later on, another classification which I believe to be better.

Just as we have learnt that the serous form of meningitis is a relatively benign affection, so we know now that an absolutely unfavourable prognosis need not necessarily be given in suppurative meningitis—at least, as long as it remains circumscribed near the original focus of suppuration in the bone. The membranes may become adherent round the diseased region and may undergo destruction within the zone of suppuration. The longer this circumscribed focus of disease remains, the greater is the danger that the adhesions may break down and the suppurative process spread in the meshes of the pia mater; therefore, in these cases also, early operation for the cure of the suppurative otitis media is advisable. As soon as the first certain signs of an intracranial complication have made their appearance, delay is no longer justifiable. I am strongly opposed to unnecessary operations and to the practice of operating on insufficient indications, but when there is any question of meningitis the rule of early operation should be followed. This may involve opening up the cranial cavity unnecessarily in a few cases, but the risk of doing so is as nothing when compared to the certainly fatal results of postponing the operation when meningitis is really present.

There can be no doubt that circumscribed suppurative meningitis is curable. In the cases successfully treated by Macewen, Lucae and Jansen, the localized focus of disease in the membranes was

actually seen during the operation. Other cases have since been reported, as we shall see later.

The symptoms in diffuse and in localized suppurative meningitis are the same, but those in the latter affection are naturally less severe. The diffuse form can be diagnosed without difficulty, if the history and the clinical picture are typical. In the course of a case of middle-ear suppuration, violent headache, nausea and vomiting set in. The temperature rises and remains more or less at the same high level (102° or 103° F.), the onset of pyrexia being sometimes accompanied by a rigor. The patient is partially unconscious; he throws himself about restlessly in bed, groans and cries out. His hands are perpetually agitated and pluck here and there at the bedclothes. It is difficult or impossible to bend the patient's head forwards owing to the rigidity of the neck muscles. The knee is often bent to a right angle and cannot be straightened (Kernig's sign). If the patient is seen in this condition and other diseases, unconnected with the aural suppuration, can be excluded, we shall be fairly safe in diagnosing suppurative meningitis, even though convulsions and paralyzes are absent. The only alternatives are tuberculous and epidemic cerebro-spinal meningitis. But, as I have stated, all the symptoms should be observable; the presence of one or two does not allow us to arrive at a definite diagnosis. Headache and vomiting are found in all intracranial complications. Pyrexia, with or without rigors, may be the outward sign of a general pyæmic infection caused by sinus thrombosis, or it may usher in the initial stages of cerebral abscess. Rigidity of the neck muscles is often seen when pathological conditions are present in the posterior fossa—for instance, in cases of cerebellar, perisinous and extradural abscess. On the other hand, rigidity as well as Kernig's sign may be absent in meningitis.

The diagnosis, then, is somewhat uncertain even when symptoms of pressure on the nerves at the base of the skull (paralysis of the eye muscles or facial paralysis) are added. These pressure paralyzes may very easily lead to confusion between meningitis and cerebral abscess.

Lumbar puncture as a diagnostic measure has yet to be considered. Within recent years a change has taken place in our view as to the value of this operation. When it was first introduced the finding of cloudy cerebro-spinal fluid, containing an increased number of leucocytes, was held to be proof positive of the existence

of purulent meningitis. Several cases, however, were reported in which a wrong diagnosis was arrived at on these lines. For instance, Ruprecht, Wolf, Grunert-Dallman and O. Voss found in their cases, on operation or post-mortem examination, uncomplicated cerebral abscess instead of the expected meningitis. The surgeons working in Schwartz's clinic found, instead of suppurative meningitis, a large meningeal hydrops in connection with increased leucocytosis and turbidity of the cerebro-spinal fluid; they were thereby compelled to give up the opinions which they had previously held (Schulze*). I have observed one case of severe septicæmia arising from ear disease, which presented a typical picture of purulent meningitis. The cerebro-spinal fluid was turbid and contained numerous pus corpuscles, but the necropsy showed that the meninges were unaffected (Grossmann†). O. Voss‡ also reported a case of general septicæmia, in which the cerebro-spinal fluid was rendered cloudy by an abnormal number of mononuclear leucocytes, but no signs of meningitis could be found.

Experiences like these show that some other method is required for the diagnosis of purulent meningitis. Stadelmann holds that, as well as pus, bacteria should be found in the fluid in order to make the diagnosis certain. This is now generally recognized, but nevertheless there are exceptional cases in which the fluid obtained by lumbar puncture contains bacteria, although no suppurative meningitis is present. In one such case Brieger refrained from operating, thinking that the disease was altogether meningeal. The patient died and the autopsy revealed a cerebral abscess with a fistula leading into the ventricle. Further, O. Voss§ has found micro-organisms in the cerebro-spinal fluid of patients suffering from sinus thrombosis. As a rule, however, we cannot go far wrong if we make a diagnosis of purulent leptomeningitis whenever bacteria and pus-corpuscles can be demonstrated in the intrameningeal liquor.

The question now arises whether it is the diffuse form of the disease which is present in these cases. If this is so, then diffuse suppurative meningitis must be curable. Gradenigo, Gerber Soko-

* 'Beitrag zur Lehre von der Otogenen Meningitis' (*A. f. O.*, Bd. lviii., S. 25).

† 'Kasuistisches zur Lumbalpunktion und Circumskripten Meningitis' (*A. f. O.*, Bd. lxiv., S. 26).

‡ 'Die Heilbarkeit der Otogenen eitrigen Meningitis usw.' (*Charité Annalen*, 29 Jahrgang, S. 24).

§ *Ibid.*, S. 28.

lowsky, Lermoyez and Bellin hold this view. They have all published cases in which turbid cerebro-spinal fluid containing bacteria was found, but nevertheless the patients recovered. Manasse holds the same opinion with regard to a case in which he removed cerebro-spinal fluid of this type by puncture and incision of the meninges at the site of the radical operation, the patient ultimately recovering. On the other hand, Hinsberg, Bertelsmann, Buschmann, Grossmann, O. Voss and others, assume that in those of their cases which ended in recovery only a localized suppurative meningitis was present. I agree with these latter surgeons, and believe that the diffuse form—*i.e.*, suppurative inflammation of the pia and arachnoid—is absolutely incurable. Von Bergmann's* dictum with regard to this disease holds good, I think, both now and for the future: 'When the pathological process has progressed to this extent, no operative measures and no attempts to clear or wash the membranes are of any avail.' Anyone who has seen during post mortem examinations on these cases how the mass of inspissated pus lies in the meshes of the pia mater will find it difficult to imagine any means by which it could be loosened and removed.

It is perhaps possible, however, to find an answer to the question whether diffuse meningitis can be, or has been, cured. I agree with Lexer† that the words 'circumscribed' and 'diffuse' have been differently understood by different authors. In discussing inflammation in serous membranes, Lexer distinguishes three forms: the encapsuled, the acutely progressive, and the general. In the encapsuled form the opposing serous surfaces are firmly bound together round the area of inflammation by fibrinous exudate and granulations. In the progressive form, either the tissues fail to effect this shutting off of the focus of inflammation, or the infection, at first confined, breaks through the protecting wall and spreads rapidly. Finally the general form, in which the whole serous lining of the cavity is involved, is a further development of the progressive variety. These different forms are best seen in suppurative peritonitis, of which the acute progressive stage may sometimes be checked by operation, but the generalized form is always fatal.

Lexer suggests that the term 'diffuse' should be abandoned, since it is sometimes used in the sense of acutely progressive, as opposed to encapsuled; sometimes to mean general, as opposed to localized.

* 'Die Chirurgische Behandlung der Hirnkrankheiten,' 3 Auflage, S. 596.

† 'Lehrbuch der Allgemeinen Chirurgie,' 2 Auflage, 1906, Bd. i., S. 248.

I, too, am of opinion that we should all agree as to the curability of diffuse meningitis if we understood the term 'diffuse' alike, or, better still, if we dropped the word altogether, and replaced it by 'general' or 'generalized.' If we accept Lexer's classification, we shall understand by 'circumscribed' the encapsuled form of meningitis (as Hinsberg* has already suggested), and not merely a limited area of inflammation. The latter type would then be classified with the progressive form, and I believe that the cases reported as cured by the authors mentioned above should be placed in this group.

Lexer's classification is meant primarily to apply to peritonitis. I think, however, that it is quite applicable to cases of meningitis if we bear in mind the anatomical differences. It is obvious that the subarachnoid space is very different from the peritoneal sac. The suppurative process will not remain confined under the arachnoid, but will soon spread in the meshes of the pia mater. It may be that, in the cases reported as cured, the inflammation was of such recent date that it had not yet had time to make much headway in the pia.

As a subdivision of the progressive form, we may perhaps place the chronic intermittent type described by Brieger, in which fresh encapsuled foci are formed in rapid succession.

The prognosis depends, firstly, on the extent to which the meningitis has spread before the operation, and, secondly, on the kind of micro-organisms which are present, and their virulence. In fifteen cases collected by O. Voss diplococci were found in eight. In six of these there was a pure diplococcal infection; in the remaining two the cocci were mixed with other organisms. In three of the fifteen cases staphylococci were found. One of the staphylococcal cases ended in recovery, from which Voss concludes that this infection is curable.

The bacteria are in some cases difficult to stain and this seems to be strong evidence that their virulence is not always the same. The strength of their toxins may, of course, be diminished by the bactericidal action of the cerebro-spinal fluid. Yet it is certain that very often the micro-organisms are of lesser virulence from the beginning and set up circumscribed meningitis, while in other cases they are of full strength and give rise to the diffuse form.

To resume, then, my opinion is that **the circumscribed and progressive forms of suppurative meningitis are curable,**

* *Z. f. O.*, Bd. xxxviii., S. 128.

but the prognosis in the generalized form is absolutely unfavourable.

From the point of view of treatment, it is of the greatest importance to decide which of these forms is present and, above all, whether we have to deal with the generalized type or not. This is not possible from the clinical picture alone, for it is only rarely that the severity of the symptoms corresponds exactly to the extent of the disease. If, however, the cerebro-spinal fluid is not only turbid, but purulent and contains micro-organisms, we may safely conclude either that the meningitis is generalized or that the acute progressive form is present in a stage which makes operative interference useless.

Kümmell* has reported a case which, I admit, seems to disprove these opinions. The patient suffered a fracture of the base of the skull and, as a result, developed symptoms of meningitis so severe that death seemed imminent. On lumbar puncture the cerebro-spinal fluid was found to be thick and purulent. Two trephine openings, each as large as a five-shilling piece, were made, one on each side of the occipital and extending partly on to the parietal bone. Strips of gauze were inserted as far as possible into the posterior fossa. The arachnoid was found to be injected, cloudy and coated; only a small amount of turbid fluid escaped. The patient recovered.

Kümmell looks on this case as 'an example of the successful treatment by operation of a diffuse suppurative leptomeningitis reaching to the cauda equina.' I cannot quite adopt his point of view, since there seems to be another plausible explanation of the case.

The whole range of symptoms of a severe attack of meningitis may be simulated, as we have seen, by subdural suppuration. I believe that this was the condition which was present in Kümmell's case. The suppuration began in the neighbourhood of the fracture and broke through into the subarachnoid space at the base of the brain. The pus then worked its way down underneath the spinal meninges. The arachnoid itself was not affected, perhaps owing to the timely operation, perhaps because the antiseptic action of the cerebro-spinal fluid weakened or abolished the virulence of the bacteria. Brieger and O. Voss have made similar observations in cases of cerebral abscess.

* 'Verhandlungen der Deutschen Gesellschaft für Chirurgie,' 1905, S. 517.

I can understand the advantages of drainage in subdural abscess, but I cannot see how drainage can have any beneficial effect when the pus lies in the meshes of the pia mater. At most this success of Kümmell's might encourage us to make one last attempt to save the patient's life by operation, in the hope of finding conditions similar to those which I believe were present in his case. Subdural suppuration, however, is not common, and perforation of pus from the subdural into the subarachnoid space without infection of the arachnoid membrane is still rarer. I believe, therefore, that we are safe in keeping to the indications for operation which we have followed up to the present.

The operation for suppurative meningitis consists in eliminating the focus of disease in the bone and exposing the dura as far as it is affected. If necessary, the membranes may be incised to allow of the escape of fluid, as is done in the serous form of meningitis. Following Witzel's suggestion, Hinsberg recommends the insertion of large strips of absorbent gauze in the neighbourhood of the focus of suppuration, in order to drain the subarachnoid space. As I have already stated, I doubt if effective drainage of this space is possible. Finally, lumbar puncture may be performed for the removal of some of the purulent cerebro-spinal fluid.

3. LUMBAR PUNCTURE.

For this operation I use a fine, very sharp trocar, running in a cannula 5 to 8 centimetres in length. The instrument must, of course, be thoroughly boiled and the skin, where the puncture is to be made, rendered aseptic. If the patient is restless, anæsthesia should be induced with ether—in my opinion a perfectly safe procedure in these cases.

The patient is laid on his side, the knees drawn up towards the chest and the shoulders bent forwards so that the back is arched. The fourth lumbar intervertebral space is then sought for (the third space is also suitable for puncture in adults), and the needle is inserted close to the middle line and at the lower edge of the fourth lumbar vertebra. The needle is pushed in a direction forwards, upwards and towards the middle line, but in children it may be inserted in the middle line itself and driven horizontally forwards. A sudden cessation of resistance tells the operator that the point of the instrument has penetrated into the spinal canal. The trocar

is then withdrawn and the cerebro-spinal fluid allowed to flow out. If the needle impinges on bone, it should be drawn back a little and pushed forwards again in a slightly different direction.

If the root of a nerve is injured, there will be twitching and pain in the corresponding part of one of the legs. Severe hæmorrhage may result from the operation, in which case the blood will flow out mixed with the cerebro-spinal fluid, or may find its way into the spinal canal. Other unpleasant accidents are breaking of the needle and stoppage of the lumen by fibrinous clots. Stadelmann mentions a case in which the point of the needle only penetrated as far as the subdural space and drew off fluid from there. According to Brieger, the free flow of cerebro-spinal fluid from the subarachnoid space may be hindered by closure of the Sylvian aqueduct, by partial sclerosis of the subarachnoid connective tissue, by adhesions in the spinal canal, or by masses of inspissated pus at the base of the skull.

It is not advisable to allow more than about 1 fluid ounce of cerebro-spinal fluid to escape at a time. I generally have the microscopic examination made immediately, the preparation being stained for tubercle bacilli in cases where there is any suspicion of tuberculosis. The tubercle bacilli are, however, more easily found if the liquor is allowed to stand until cobweblike masses have formed in it and a sediment has been deposited.

After the operation the wound in the skin is closed with a small piece of adhesive plaster.

As a therapeutic measure lumbar puncture is used in cases of serous and purulent meningitis. The symptoms of compression disappear after the operation, but recur later, necessitating a repetition of the puncture.

Many surgeons consider that lumbar puncture is altogether without danger in cases of intracranial complications of aural suppuration. This is not by any means true. It has been the direct cause of death in a fairly large number of cases of brain tumour. Körner rightly points out, too, that the sudden withdrawal of fluid may cause adhesions to break down, thus setting free an encapsuled abscess, or may even determine the perforation of such an abscess into the ventricle. Two cases of death after lumbar puncture have been reported from Schwartz's clinic*. In one of these the fatal termination was ascribed to aspiration with Pravaz's syringe, the method then in vogue; in the other death was probably due to chloroform-

* Braunstein, 'Bedeutung der Lumbalpunktion,' etc., Bd. liv., S. 45 *et seq.*

poisoning. Even if these cases do not directly prove that lumbar puncture is dangerous, they should at least make the surgeon inclined to be cautious. I cannot agree with Braunstein when he says in the paper referred to above: 'The solution of this question (*i.e.*, of the danger or otherwise of puncture) is of no practical importance. Even if death occurred unexpectedly soon after puncture in a few cases, the patients were in such a condition before the operation that the *exitus* might have been expected at any moment, and lumbar puncture cannot on this evidence be declared to be dangerous.'

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I believe that the operation may endanger the patient's life, and for a considerable time I gave it up altogether. Recently, however, I have performed it occasionally, but only on certain very definite indications. If the clinical picture makes the diagnosis 'suppurative meningitis' probable, lumbar puncture should be carried out to remove any doubt that may remain. If the cerebro-spinal fluid is found to be purulent and to contain bacteria, further operative measures are useless. If the fluid is only turbid, even though bacteria are found, the cranium should be opened. If the fluid is purulent without micro-organisms or clear with micro-organisms, I now always operate. When a patient is so weak that any operation is dangerous, lumbar puncture should be done, so that the surgeon may learn whether there is anything to be hoped for from further interference or not. The following case is a good example. The patient was suffering from very fetid chronic middle-ear suppuration and was exceedingly weak. The radical operation was performed and, since cerebellar symptoms were present, the cerebellum was exposed and punctured several times with negative results. Nevertheless we were undecided whether to diagnose a deeply situated cerebellar abscess difficult to reach, or diffuse suppurative meningitis. If we had punctured the spinal canal in this case, we should have found clear cerebro-spinal fluid, and on this finding attempted a further operation. We might, perhaps, have removed the labyrinth and discovered the abscess which we found at the post-mortem examination. There was no inflammation of the membranes.

In other cases, if there is a doubt whether meningitis or some other intracranial complication is present, I prefer to do the radical

operation. The patient is not exposed thereby to any danger, and an error of diagnosis, such as that made in Brieger's case (see p. 190), is avoided.

If the radical operation does not make clear the cause of the clinical signs and symptoms, I do lumbar puncture as well, and from the result of this I am able to decide whether the radical opening up of the middle-ear spaces suffices or if further operative measures are necessary.

4. PUNCTURE OF THE CEREBRAL VENTRICLES.

Bönningshaus* recommends puncture of the cerebral ventricles in the so-called internal serous meningitis which is said to be the only condition that causes distension of the ventricular cavity with fluid.

In children one of the lateral ventricles can be punctured through the corresponding lateral angle of the anterior or posterior fontanelle. In adults the needle may be pushed in towards the lateral ventricle through the dura covering the temporal lobe, when this has been exposed in the course of the radical operation. If the ventricle is distended it can scarcely be missed, and is found at a depth of about 4 to 6 centimetres.

Brieger considers that there is not sufficient evidence for assuming that exclusively ventricular meningitis ever occurs, and he is, therefore, in favour of lumbar puncture alone in every case of serous meningitis. If this does not relieve the brain from the pressure of the cerebro-spinal fluid, he suggests that free incision of the membranes should be considered. The main thing, however, in every case is to eliminate the primary focus of disease which has caused the serous meningitis.

* 'Die Meningitis Serosa' (Wiesbaden: J. F. Bergmann, 1897).

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